OVERSIGHT HEARING ON THE GENERAL ACCOUNTING OFFICE STUDY ON FOREST HEALTH

OVERSIGHT HEARING

BEFORE THE

SUBCOMMITTEE ON FOREST AND FOREST HEALTH

OF THE

COMMITTEE ON RESOURCES
HOUSE OF REPRESENTATIVES

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OVERSIGHT HEARING ON THE GENERAL ACCOUNTING OFFICE STUDY ON FOREST HEALTH

MONDAY, SEPTEMBER 28, 1998

House of Representatives,
Subcommittee on Forests and Forest Health,
Committee on Resources,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:07 p.m., in room 1324, Longworth House Office Building, Hon. Helen Chenoweth (chairman of the Subcommittee) presiding.

STATEMENT OF HON. HELEN CHENOWETH, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF IDAHO

Mrs. Chenoweth. The Subcommittee on Forests and Forest Health will come to order. The Subcommittee is meeting today to hear testimony on GAO's study on the forests' health.

Under rule 4(g) of the Committee rules, any oral opening statements at hearings are limited to the chairman and the Ranking Minority Member. This will allow us to hear from our witnesses sooner and help members keep to their schedules. Therefore, if other members have statements, they can be included in the hearing record under unanimous consent.

The Subcommittee has held countless oversight hearings and briefings on the subject of the health of our national forests, and during this time we have learned that forest health conditions vary greatly across the country. On some national forests we find dynamic and healthy systems that are highly resistant to insect and disease epidemics. Those forests are found mostly in the East and the Northeast.

On other forests we find conditions that the scientists tell us are far outside of their historic range of variability. Mostly, we find those conditions in the West where, for example, stand densities are much higher then they ever have been. In these areas we have too many trees and shrubs fighting for limited nutrients and moisture. These weakened forests are easy targets for insects and disease and then, ultimately, for unnaturally large hot fires. These conditions are mirrored in the national timber growth statistics.

According to the Forest Service, the total annual tree growth of the national forests is about 23 billion board feet. If you subtract the annual harvest of 3 billion board feet and the annual mortality of 6 billion board feet, you find that the net growth rate in our national forests is an astounding 14 billion board feet each year. That's an addition every single year of 14 billion board feet.

In some areas this represents a great success in reforestation, while in other areas it represents overcrowded forests that are simply waiting to be burned. These numbers also show that we are currently harvesting less than 13 percent of the total growth—just the growth—and only half of what is dying. We're only harvesting half of the mortality rate. This is what's causing such a heavy fuel load on our forest floors, and these numbers are not—and this philosophy is not—sustainable.

Too much growth can have as serious the consequences as too little growth and is, in fact, the reason why the total number and size of fires has dramatically increased in the last few years and will certainly continue to increase if aggressive management measures aren't taken.

This is the purpose of today's hearing, to hear the preliminary findings from the GAO's long-term analysis on forest health conditions on national forests and to hear from the Forest Service on their programs and proposals for addressing serious forest health problems.

[The prepared statement of Mrs. Chenoweth follows:]

STATEMENT OF HON. HELEN CHENOWETH, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF IDAHO

This Subcommittee has held countless oversight hearings and briefings on the subject of the health of our national forests. During this time we have learned that forest health conditions vary greatly across the country. On some national forests we find dynamic and healthy systems that are highly resistant to insect and disease epidemics. On other forests, we find conditions that the scientists tell us are far outside of their historic ranges of variability, where, for example, stand densities are much higher than they ever have been. In these areas we have too many trees and shrubs fighting for limited nutrients and moisture. These weakened forests are easy targets for insects and disease, and then ultimately for unnaturally large hot fires. These conditions are mirrored in the national timber growth statistics:

According to the Forest Service, the total annual tree growth on the national forests is about 23 billion board feet. If you subtract the annual harvest of 3 bbf and the annual mortality of 6 bbf, you find that the net growth on our national forests is an astounding 14 bbf each year. In some areas this represents a great success in reforestation, while in other areas it represents overcrowded forests that are waiting to burn. These numbers also show that we are currently harvesting less than 13 percent of total growth and only half of what is dying. These numbers are *not* sustainable—too much growth can have as serious the consequences as too little, and is, in fact, the reason why the total number and size of fires has dramatically increased +n the last few years—and will certainly continue to increase if aggressive management measures aren't taken.

This is the purpose of today's hearing: to hear the preliminary findings from the GAO's long-term analysis on forest health conditions on national forests, and to hear from the Forest Service on their programs and proposals for addressing serious forest health problems.

BRIEFING PAPER

GAO STUDY ON FOREST HEALTH

SEPTEMBER 28, 1998

SUMMARY:

The House Resources Subcommittee on Forests and Forest Health will hold an oversight hearing on forest health conditions on national forests and the Forest Service's programs and plans for dealing with forest health problems. Particularly, the hearing will focus on the preliminary findings of a longterm and ongoing General Accounting Office (GAO) study assessing forest health conditions on national forests.

BACKGROUND AND ANALYSIS:

The Forests and Forest Health Subcommittee has held numerous oversight hearings concerning the health conditions of Federal forests. The findings of these hearings have overwhelmingly shown that forest health problems persist on many national forests, and Forest Service management activities to deal with these problems are woefully insufficient. In order to determine the validity of these findings, the Subcommittee requested that the GAO analyze forest health problems on national forests in the Inland West and the Forest Service units' responses to them. The specific objectives of the assignment were to answer the following questions:

(1)What is known about the extent and seriousness of national forest health conditions in the Interior West?

(2)How have different national forests responded to these conditions?

(3)What factors influence forests' responses and how?

(4)What options might improve effectiveness and efficiency of responses?

The GAO initiated this study in December of 1997. Although a final report will not be ready until early in 1999, the GAO has generated some preliminary findings and will present them at the hearing.

A recent publication from the American Forests' Forest Policy Center, titled: *Forest Health in the United States,* addresses these same concerns. Authors Neil Sampson and Lester DeCoster give an overview of forest health conditions and concerns in a diverse range of forest types and regions across the country. This important publication is the most up-to-date and thorough examination of this subject available. Neil Sampson will be presenting information from this publication at the hearing.

WITNESSES:

A witness list is attached

STAFF CONTACT:

Doug Crandall, 225-0691

Mrs. CHENOWETH. Now, since we don't have the Ranking Minority Member here, I would like to recognize our Ranking Majority Member, Mr. Jim Hansen, for any comments that he has. He has carried this fight, even when he was in the Minority, with great success, and it's my privilege to have him on the Committee.

Mr. Hansen.

STATEMENT OF HON. JAMES V. HANSEN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF UTAH

Mr. HANSEN. Well, thank you, Madam Chairman. I've read the GAO report briefly, I have to admit, and I'm somewhat confused about it. In one case we talk about the idea that we have to have fires and that fires in the past have been the things that have mitigated the problems. Having been on this Committee for 18 years and spent a lot of time with forest supervisors, I'm not quite sure if I understand what we're saying here—controlled fires.

We have clean water problems, clean air problems that are staring us in the face. We have fuel loads that are totally unbelievable in the West now because we're not doing much in the way of thinning. Our fires that are controlled are somewhat regulated. The insects that we have in many of the forests are rampant, and every time a forest supervisor tries to do something about it he gets a lawsuit from one of these environmental groups, and now we've killed out, basically, the Dixie Forest in Utah—it's almost dead, as we can't seem to get a handle on that. Every time they get one adjudicated another one hits them between the eyes.

I'll be interested in listening to the GAO, as I've listened to them many times on reports in various areas, because it seems to me they outlined every problem. I'm not sure I saw any solutions, and I guess maybe that's not your position, but I'm very concerned that no one has yet come up with some good problems. I've heard the gentlelady from Idaho, the chairman of the Committee, talk about some fairly decent solutions, and I'm speaking to generalities because I don't know what else to do.

You go into Yellowstone; half the people up there say this is horrible that the Park Service allowed this to go on. It cost one lady her job out of Denver. Other people say, "Hey, it was the best thing that ever happened. Now new growth can come about." I wish the real experts on this thing would stand up. The only thing that I've seen when I chaired this Committee was going into areas that were privately owned, like Weyerhaeuser, and noticing how healthy their forests were, that they had beautiful forests, a lot of game in them. They didn't have any of the fuel load or dead fall and all of these things that others have.

And with those many sweeping generalities, Madam Chairman, I look forward to hearing the testimony from the GAO and others.

Mrs. CHENOWETH. Thank you, Mr. Hansen. Mr. Peterson, do you have any comments?

Mr. PETERSON. No, Madam Chairman.

[The prepared statement of Mr. Herger follows:]

STATEMENT OF HON. WALLY HERGER, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Madam Chairman, Members of the Subcommittee, I appreciate this opportunity to testify today regarding the current, unhealthy state of our National Forests. This issue is critically important to the district I represent in Northern California. California's Second Congressional District is home to all or parts of 11 national forests. The quality of maintenance and management on these forests has a direct impact on the quality of life of the people who live and work in my district and on the safety and protection of private lands surrounding these forests. When a fire, infestation, or disease starts on public lands it can easily get out of hand and spread onto private lands. Maintaining healthy national forests, therefore, is not only good environmental policy, but it is a good neighbor policy. Unfortunately, as things now stand, the U.S. Forest Service is not being a good neighbor.

The Forest Service estimates that more than 40 million acres of our national forests are currently under a severe threat of destruction by catastrophic wildfire.

The danger of this threat is particularly strong in forests in the Western United States. Unlike other forests in other parts of the country, forests in the West suffer from unusually high incidents of fire. During hot summer months these forests receive very little rainfall. Historically, Western forests were filled with stands of large trees. The forest floors were less dense and were naturally and regularly thinned by lightening and native caused fires that would clean out dense underbrush leaving the big trees to grow bigger. However, because of decades of well-meaning but aggressive fire suppression practices, these forests have grown out of hand, creating an almost overwhelming threat of catastrophic fire.

According to U.S. Forest Service estimates, our national forests are 82 percent denser than they were in 1928. Thick undergrowth, combined with increasingly taller layers of intermediate trees has turned western forests into deadly fire time bombs. Now when a fire starts, it quickly climbs up the dense tree growth like a ladder until it tops out at the uppermost, or crown, level of the forest and races out of control as a catastrophic fire. Because of their high speed and intense heat, "crown fires" are nothing like the healthy fires of the past, but these fires have the capacity of leaving an almost sterile environment in their wake with almost no vegetation, wildlife, or habitat left behind.

These dangerous conditions, however, are not irreversible. The forest service can proactively improve forest health. Regrettably, proactive policies are not being implemented. Because of mandates from the Forest Service's Washington offices and directives from the Clinton/Gore Administration, the forest service suffers from a virtual paralysis. Evidence of this paralysis can be found in the way the forest service increasingly uses its trust funds to pay for administration instead of funding on-the-ground forest health projects and in the way the agency advocates management by moratorium rather than managing by sound scientific evidence.

Madam Chairman, this agency must move away from its current extreme environmental agenda that has set up our national forests for destruction. We must require the Service to implement more proactive, on-the-ground programs, like the Quincy Library Group proposal, that would restore forest health while providing economic stability for local communities.

I therefore encourage the GAO, the Forest Service and this Committee to examine the latest science and find ways to implement programs that will return our forests to a healthier, more fire resilient condition.

Mrs. CHENOWETH. Well, with that, I'd like to introduce the first panel. Our sole panelist for the first panel is Mr. Barry Hill, Associate Director, Energy, Resources and Science Issues with the GAO. And, Mr. Hill, I wonder if you might introduce the party who is accompanying you at the table.

Mr. HILL. Yes, Madam Chairman. With me today is Chet Joy, who led the work on this project.

Mrs. CHENOWETH. Thank you, Mr. Hill. Mr. Joy, we welcome you.

And as explained in our first hearing, it is the intention of the chairman to place all outside witnesses under the oath. This is a formality of the Committee that is meant to assure open and honest discussion and should not affect the testimony given by witnesses. I believe all of the witnesses were informed of this procedure before appearing here today and that they have been supplied with a copy of the Committee rules.

So, with that, would you please—both of you—please stand and raise your hand to the square?

[Witnesses sworn.]

Thank you. Under the Committee rules, witnesses must limit their oral statements to 5 minutes. However, I will waive the rules and allow Mr. Hill 10 minutes, because we have been waiting for this preliminary report for a very, very long time. His entire statement, of course, will appear in the record.

The chairman now recognizes Mr. Hill to testify.

STATEMENT OF BARRY HILL, ASSOCIATE DIRECTOR, ENERGY, RESOURCES AND SCIENCE ISSUES, GENERAL ACCOUNTING OFFICE, WASHINGTON, DC; ACCOMPANIED BY CHESTER JOY, SENIOR EVALUATOR, ENERGY, RESOURCES AND SCIENCE ISSUES, GENERAL ACCOUNTING OFFICE, WASHINGTON, DC; RYAN COLES

Mr. HILL. Thank you, Madam Chairman. May I also say, with us today is Ryan Coles, here on my left, who also worked on this project and who, along with Ross Campbell, on our right, will be helping out with the charts that we brought today.

We're pleased to be here today to discuss our preliminary observations on the health of the national forests located in the interior West. If I may, I'd like to briefly summarize my prepared statement and submit the formal statement for the record.

Mrs. CHENOWETH. Without objection, so ordered.

Mr. HILL. And before I begin I'd like to kind of begin my statement with a brief video clip provided to us courtesy of The Learning Channel, and I think you'll find very interesting.

[Video.]

Madam Chairman, this video clip illustrates what we believe is the most serious forest health-related problem on national forests of the interior West: catastrophic wildfires and the dangers they present when population and catastrophic wildfire exist together. This afternoon we'll discuss what the problem is, why it exists, and what is being done about it. Let me start by discussing what the problem is.

The Forest Service estimated in 1995 that about 39 million acres, or about a third of these forests, are at high risk of catastrophic wildfires. Experts have estimated that the window of opportunity to take action before widespread damage occurs is only about 10 to 25 years. On the basis of the best available information, efforts to resolve this problem by the year 2015, which is the mid-point of that window, may cost as much as $12 billion or about $725 million per year. However, the Forest Service's current plans to do so may leave as many as 10 million acres still at high risk at that time.

The interior West region we are talking about is the dry inland portion of the Western United States shown on the map to my left. For those of you who may not be able to clearly see these exhibits, they're also included as appendixes to our formal statement.

There are many reasons why national forests in this region are in their current state. Historically, the region's lower elevation forests were subject to frequent low-intensity fires, though occasions of these frequent fire forests, which are generally dominated by ponderosa pine, are depicted in our next exhibit to my right. Frequent fire generally kept the trees in these forests few in number and their undergrowth sparse, as shown in our next exhibit on the left here, which is a 1909 photograph of a Ponderosa pine stand in the Bitterroot National Forest in Idaho.

Many past human activities, including some prior to Forest Service management, eliminated these frequent fires. As a result, tree stands have become much more dense, as shown in our next exhibit, which is a photograph taken from the identical spot in 1989, 80 years later. The most significant contributor to this increase in tree stand density has been the agency's decades-old policy of suppressing wildfires.

Our next exhibit on the left shows the change since 1910 in the number of acres burned annually by wildfires in national forests, over 90 percent of which occurred in the interior West. You'll notice that for about 75 years, fire suppression was very successful.

However, in about 1984 this turned around, and since then the number of acres burned annually has been increasing. The reason for this is because the increased stand density caused changes in the species mix of trees and some increases in insect and disease infestations, resulting in high accumulations of fuels for fires. Because of these accumulated fuels, fires are now much more likely to become large, intense, and catastrophic wildfires. The increase in the number of large fires since 1984 and in the number of acres that they burn, which has more than quadrupled, is shown in our next exhibit, to my right.

Since 1990, 91 percent of these large fires and 96 percent of the acres burned were in the interior West. A 1998 estimate of the locations of forests in the interior West that are at medium and high risk of such catastrophic wildfires is shown in the exhibit to my left. Such fires are catastrophic because they can seriously compromise the agency's ability to sustain wildlife and fish, clean water, timber, and recreational opportunities, often for many decades or even for centuries.

Especially troubling are the hazards that these large fires pose to human health, safety, and property, especially along the boundaries of forests where population has grown rapidly in recent years.

Our next exhibit shows the recent population growth in this so-called wildland urban interface. Areas shown in blue are counties where the population grew at a faster rate than average. You'll notice that these areas are often concentrated around the national forests, which are shown in green.

In addition, as shown in our next two exhibits, the cost to both prepare for and to fight these increasing numbers of catastrophic wildfires are also increasing rapidly, largely because of the higher costs in interface areas. As these exhibits show, the average cost for fighting fire grew from $134 million in 1986 to $335 million in 1994, or by about 150 percent. Ninety-five percent of these costs were incurred in the interior West. Moreover, the costs associated with preparedness increased from $189 million in 1992 to $326 million in 1997.

It should be clear, Madam Chairman, that there is a very serious forest health problem in the forests of the interior West. The Forest Service has taken several steps to address the situation. Recently, it initiated a forest health monitoring program. It has also refocused its fire management program to increase the number of acres on which it undertakes fuels reduction activities and has restructured its budget to better ensure that funds are available to carry out this important work.

The Congress has supported the agency in this task by increasing funds for fuels reduction and authorizing a multi-year interagency program to better assess problems and solutions. However, it appears to us that the Forest Service does not yet have a cohesive strategy for overcoming the barriers to improving forest health by reducing accumulated fuels, partly because of a lack of data and partly because its current efforts are largely devoted to maintaining conditions on forests currently at low risk of fire.

In addition, methods for reducing fuels can adversely affect agency achievement of its other stewardship objectives, such as protecting watersheds and wildlife. Controlled fires can be used, but there is concern that such fires might get out of control and about the effects on air quality of the smoke from these fires. Therefore, mechanical methods, including timber harvesting, will often be necessary to remove accumulated fuels.

But this is also problematic, because the Forest Service's incentives tend to focus efforts on areas that may not present the greatest fire hazard. Also, timber sale and other contracting procedures are not designed for removing vast quantities of materials with little or no commercial value.

In conclusion, Madam Chairman, the increasing number of uncontrollable and often catastrophic wildfires and the growing risk to human health, safety, and property, as well as to resources in the interior West, present difficult policy decisions for the Forest Service and the Congress:

> Does the agency request and does the Congress appropriate the hundreds of millions of dollars annually that may be required to fund an aggressive fuels reduction program? What priorities should be established? How can the need to reinforce fire into these frequent fire forests best be reconciled with air quality standards and other agency stewardship objectives? What changes in incentives and statutorily defined contracting procedures will facilitate the mechanical removal of low-value materials?

These decisions should be based on sound strategy. That strategy in turn depends on data being gathered under the Forest Service's and the Department of Interior's joint fire science program to be conducted over the next decade and subsequently integrated into individual forest plans and projects.

However, many experts argue that the agency and Congress are in a race against time, and that the tinder box that is now the interior West simply cannot wait that long. Taking aggressive, strategic actions now would likely cost less than just allowing nature to take its inevitable course.

Madam Chairman, this concludes my prepared statement. I'd be pleased to answer any questions that you or other members may have.

[The prepared statement of Mr. Hill may be found at end of hearing.]

Mrs. CHENOWETH. Thank you, Mr. Hill. That was very good testimony, and I appreciate it.

At this time the Chair will recognize Mr. Hansen for any questions he might have.

Mr. HANSEN. Mr. Hill, I think you did a very fine job in explaining the problem that we have here. I really don't know if you're the one to ask about solutions. You've done it very well; you've explained it. I wonder about harvesting of timber. I think Congress has created so many laws that it becomes very difficult for people to move.

For example, the Clean Air Act; we could do more controlled burning, but we worry about that. The Endangered Species Act; people are of the opinion that if we go in and take out some forests, we'll disrupt some species at some place. The Clean Water Act; we also find that problem. We find that like our country just above us—Canada, as you know, for a short time they outlawed grazing, and then they found out that all those grasses were not taken down by a certain amount of slaughter animals and actually paid people in Montana and the Dakotas to take their sheep and cattle up there to keep their grasses down.

As I mentioned earlier, the spruce beetle creates a devastating thing. Years ago the Forest Service testified that it was $8.40 a tree—I imagined that's changed since then—to spray them, but they would have to do a tree twice a week for 3 or 4 months, which became impossible. So the Forest supervisor said, well what they ought to do is go in and harvest that heavily infested area and then the strong trees on the periphery would make it.

So I, with all those obstructions staring us in the face and the tools that are used being somewhat hampered, I guess it comes down to the idea that we just say, "What do you say if we just let

Mother Nature do it? Let her rip." And I think that's what the environmental communities are basically saying is, just let Mother Nature do it, and we'll just take whatever happens. Am I reading this wrong?

Mr. HILL. No. I think that you very adequately characterize the heart of the issue. There's a very, very serious problem, particularly in the interior West in terms of the conditions of the forests. I'm not sure allowing Mother Nature to take its course is a good solution to this problem. The fact is, the forests that are in the interior West are no longer natural forests. They have been shaped, they have been made into the condition they have been made into by human activity over the years.

If they were natural, you could say let nature take its course, but the current condition they are in, if you allow so-called nature to take its course and to have these fires burn, they will be catastrophic fires, and they will have serious and significant adverse impacts to the forests, to the wildlife, to the human habitat and housing and residents that live around the forests. It's—I guess the analogy is it's kind of like we've pushed a boulder down a hillside and it's picking up speed toward a village below. Do we say, let gravity take its course? That's certainly a choice, but I'm not sure it's a good choice right now, not one that's acceptable in terms of the consequences that you'd pay.

Mr. HANSEN. You know, Mr. Hill, the longer I listen to these debates, of which I've listened to hundreds of hours of them, it seems to come down to two schools of thought. One is the let Mother Nature do it thought: let's just take whatever happens. And the other one comes down to the management thought. Let's say man has a stewardship to take care of the ground, which a lot of people believe, and I subscribe to that theory. But you get down to it, and the trouble with the let nature take its course thing is it is detrimental to everything.

For example, years ago we had some Forest Service people in here, and then we had a lot of land grant college professors here. And one person brought up the statement, and he said, "Look at the north slope of the Uinta mountains. It's just a beautiful green carpet. Leave it alone. Don't go in and manage it." The fellow from Utah State University, who was the expert on it, he said, "However, we have an infestation of pine beetle, and if we don't go in and spray or cut those out," he said, "it will have a devastating effect."

The chairman of the committee then asked the question, "What would be the devastating effect?" He said, "That beautiful green carpet that you fly over will soon be dead. I have a series of pictures of the Dixie, for example, when it was green, then red, then grey, then dead because we didn't do anything." And he said, "I will guarantee everybody in this room"—and this place was packed—"that that will be a dead forest in a relatively short time."

He went on to say, "I further guarantee that there will be a fire." He said, "There is no way on God's earth"—direct quote—"that you can't prevent a fire, whether it's a careless cigarette, it's a lightening strike, or by other means—a campfire." He said, "I will further guarantee there will then be a flood." And he said, "to bring back that beautiful green carpet that we've elected not to manage—we let Mother Nature do it; we're not going to do it—that it will take 50 to 60 or 70 years, if we're lucky, to bring it back in that green carpet that this gentleman, who wanted to let Mother Nature do it, was subscribing to that theory.

So, this quandary never ends. Which way do we want to do it? And I think the Committee—and, of course, I can't speak for other members, but I think we've come down on the idea that we can adequately manage the public lands of America, but we have all of these conflicting things coming at us, like the Endangered Species Act and the Clean Air Act, and it just, in effect, ties the hands of our Forest supervisors and our BLM managers to the point they're almost throwing up their hands in despair and say, "Well, what do I do?"

You take Hugh Thompson—been in this business for years and years. He's the Forest supervisor of the Dixie, 67 years old, or so, should retire. They keep asking to keep him on, and he says, "I wish we would have some scientists around here instead of people that have the burning in their bosom without any scientific knowledge."

And then it really disturbs me when the Forest Service kind of quietly says to our Forest supervisors in the West, "Well, let the environmental community win a few." And if I could put them under oath—I think I someday will do that—and get the exact quotes and who it came from, because that is the way this administration likes to look at it. Excuse the last part, Madam Chairman, but that part irritates the heck out of me, because I don't care what the administration is. We should do what is right for the—all of us who are in America, and take care of it.

I didn't mean to throw all of those things up at you, Mr. Hill. I appreciate your very interesting report, and I think you've outlined it very well. I just wish I knew the answer to all these things. I'll turn to wiser heads than me for that, I'm sure.

Mrs. CHENOWETH. Thank you, Mr. Hansen. The Chair now recognizes Mr. Peterson, the gentleman from Pennsylvania.

Mr. PETERSON. Thank you. I'd like to thank the gentleman, Mr. Hill, for his precise comments. You talked about 39 million acres, you talked about low-volume a lot of the wood is—I mean low-value wood. What is the potential market for that? Can it be used for pulp, for paper mills? Can it be—is there any potential market for low-value wood? I'm from the East, where that's what we do with it.

Mr. JOY. Yes, Mr. Peterson, there are in fact some uses for some of it, but there is a large amount of it in the interior West that, A, is of extremely low value, and B, is very far from markets. There are a lot of transportation costs that you don't have in the State of Pennsylvania that they have to deal with.

There are also other uses for it, aside from pulp, like biomass burning and things like that, and ethanol. However, that's at the edge of the market right now. That's going up and down, so there's nothing reliable for much of this material. I think it's fair to say, there's not any consistent or secure market for any long period of time that anybody wants to make a long-term investment in.

Mr. PETERSON. But would—now I've watched in the West and the East, where we have oriented strand board plants now; we have fiber board plants of different kinds, which is a huge growing market, and that's basically sawdust and chips depending on which board they're making.

Mr. JOY. The best way, Congressman Peterson, I can answer it is, on September 30 of last year, I believe it was, Secretary of Interior Babbitt was here speaking on this subject and about a lot of their concerns about it, and he pointed to a Mescalero Indian reservation that was producing a whole bunch of materials for a biomass ulilization plant in Arizona. That plant in Arizona is closed—Stone Container. So, it's an up and down thing, so that's it's difficult to have a long, consistent——

Mr. PETERSON. Well, I guess what I was going to get to is if you're going to have someone invest in that part of the country to utilize the low-value wood—and there are ways to do that—you'd have to guarantee them a continual supply ongoingly, and with the lawsuits we face and the preservationists who want it to lay there for the insects, I mean, how do we prepare, how do we get a marketplace that would make it feasible to remove this low quality, dying——

Mr. JOY. That was not something that we looked at in this phase. First of all, these are just preliminary observations without any conclusions or recommendations. It's an issue which we raise as a problem at this point, but we haven't thoroughly analyzed it yet.

Mr. PETERSON. Yes, I understand. I know you weren't——

Mr. JOY. I don't know if it would necessarily——

Mr. PETERSON. But would it make some sense from your——

Mr. HILL. Mr. Peterson, you know, I believe a lot of this is dependent upon the specific location, the geographical area of where this timber would be. So it's hard to give any generalities. Certainly, I think the Forest Service and the other land management agencies need to explore doing more of this, and they need to provide more incentives, if necessary, for commercial companies to come in and do this type of work. Even if it's not economically feasible, it might be a good investment in some areas to do something like this.

Mr. PETERSON. But if you're looking for ways to dispose of it to prevent fires, it would seem like you would have to develop a market, and could that be part of your recommendation, that there be some effort at the Forest Service level to develop a market for low-quality wood products and where they would guarantee a certain supply out of a region so that—you know, these are huge investments. These plants——

Mr. HILL. Right.

Mr. PETERSON [continuing]. Even the small ones are $100 million, so you're talking about a large investment, but they do consume a lot of low quality wood product that has no value otherwise.

Mr. HILL. That's something the Forest Service should be considering as it develops whatever strategies it's developing to deal with the problem, certainly.

Mr. PETERSON. You certainly can't cut it and haul it for any great distance. I mean, it just isn't feasible, the cost of hauling, I'm sure, in that area. OK, I was——

Mr. HILL. You know, the analogy here would almost be like when this country started to first recycle materials. It wasn't always economically feasible, and we basically developed market over the years so that now we do have a much better recycling program than we did 10 or 15 years ago. Maybe a similar effort would be warranted here. Maybe it's not economically feasible right now, but something that we need to explore just in terms of helping the situation and resolving the problem in the future.

Mr. PETERSON. Thank you.

Mrs. CHENOWETH. Thank you, Mr. Peterson. Mr. Hill, I do want to say that for the record, the two associates that you brought with you——

Mr. HILL. Yes.

Mrs. CHENOWETH [continuing]. that helped with the posters, I wonder if before you leave you could give their full names to the court reporter before you leave.

Mr. HILL. OK.

Mrs. CHENOWETH. And the spelling and so forth, because I don't think she caught it.

Mr. HILL. Sure.

Mrs. CHENOWETH. You mentioned in your testimony, and of course you showed us on the poster, that there were some areas that were absolutely red catastrophic, some others that were not so bad—other forest areas in the inland West—that were depicted in orange. In your studies, have you found out why the Forest Service has not just gotten in to the red areas and gotten something done? Have they—I mean, that's a sizable chunk there. Why aren't——

Mr. JOY. Madam Chairman, I think——

Mrs. CHENOWETH. Why aren't they prioritizing their work and focusing on those catastrophic areas?

Mr. HILL. That's a good question, and I may say that the Forest Service has been basically ramping up their program recently. A lot of their effort has been directed to the southeast area of the country, which doesn't have a problem, largely because that's where their attention has been for many years now. Their planning in the next few years——

Mrs. CHENOWETH. Let me ask you before you proceed, and I don't mean to interrupt you——

Mr. HILL. Sure.

Mrs. CHENOWETH [continuing]. But isn't the Southeast mostly private forest though? I mean, there aren't huge blocks of national forest in the Southeast.

Mr. JOY. Madam Chairman, that's correct. The majority of the Forest Service's holdings are, in fact, in the dry interior West here compared to there. However, this discussion was held about 60 or 70 years ago in probably a room like this over the issue of the Southeast, and the Southeast began a program many years ago that has maintained those forests, which are also short interval fire ones, but has maintained them in much safer fuel conditions. If the Forest Service discontinues that program, they will be faced with a similar problem.

The Forest Service is just now approaching this issue here, and in terms of going to the worst spots, central to what one of the big difficulties is, this is not prepared by the Forest Service. This is prepared by an outside analysis firm, an analytic, professional group. The Forest Service has a series of different maps in the forests we visited. Some of them have done this kind of analysis, others have not. So not all of them can say right now where their problems are or code their forests yet.

The Forest Service has a program, this Joint Fire Science Program, whose initial studies the results—some of the results in conjunction with this, will be out this December. It is our understanding they're going to have some sort of a fuel loading mapping at that time, but they don't have it yet.

Mrs. CHENOWETH. Thank you, Mr. Joy. Mr. Hill.

Mr. HILL. Yes. What I was going to say is I think the Forest Service realizes the severity of the problem now. Hopefully, it's not too little, too late. And they have—they are proposing to increase the amount of acres that they will be reducing the fuels—the accumulated fuels—from about a half-a-million a year up to 3 million acres a year by the year 2000, and then they plan to sustain that level of removal over the next 15 to 20 years. Most of that increase will occur in the interior West. That's where they are going to be focusing the greatest amount of increase in the removal of those accumulated fuels.

Mrs. CHENOWETH. Well, Mr. Hill, even given the figures you just now gave me, your testimony reflects the fact that there may still be 10 million acres left at high risk. How did you come up with those figures, and is that true?

Mr. HILL. Well, based on our rough estimates—and I do say rough estimates because there is not a lot of precise data on this—but based on the estimates that are available from the Forest Service and from other experts we've talked to, the estimate is that there are 39 million acres that need the accumulated fuel needs to be removed and dealt with. Most of that's in the interior West. If you look at their numbers, if they're going to increase 3 million acres removal by the year 2000, 1 million of which will continue to be outside that interior West area, so with 2 million being devoted to the interior West over a 15 to 16-year period, you can see that's about 10 million acres short of dealing with the entire situation.

And may I say, the problem is even more complex because, quite frankly, they don't really have a good feel right now for where those high risk areas are and where the removals need to be done, and they're trying to get that data, but it's going to take them a while to get it. And certainly as they're continuing to study that and to get the data, the problem actually gets worse because more accumulated fuel is piling up all the time.

Mrs. CHENOWETH. And this will cost about $12 billion?

Mr. HILL. Based on our estimate, we're talking an investment of $12 billion to remove this fuel.

Mrs. CHENOWETH. What was our budget?

[Confers with staff.]

Mr. HILL. And that's based on an average cost of removal of $320 an acre times, basically, the 39 million acres.

Mrs. CHENOWETH. I see.

Mr. JOY. Madam Chairman, if I could just expand to one thing, a point on that, and that is that it may be that the Forest Service doesn't have to do all the 39 million or whatever the acreage might be, if they can develop some strategic method for prioritizing it so that they can still protect the towns, et cetera.

The difficulty is, though, until you do have such a strategy, there's really no grounds for just ruling out and ignoring one acre or another. But it is possible they could do less than all of it, but they'll have to be strategic about it, and that's the plan that's not there quite yet.

Mrs. CHENOWETH. And thank you, Mr. Joy, and I really don't—I'm not real optimistic when we have a roadless moratorium in place, where it's very difficult to get to the areas that need to be taken care of.

I see my time is up, and, as you know, I have a lot more questions to ask you, and I want to thank you very, very much for your very valuable testimony.

And Mr. Hill, I understand that through the winter you'll be continuing to work on this, on my question of about 2 years ago, how we prioritize the forests with regards to which is the worst and which is the best in listing how our forest conditions are in terms of forest health today. So I understand that you'll be giving us a final report late winter. Is that correct?

Mr. HILL. That's correct. We're hoping to get it done by late winter, and we're hoping that the work we're going to be doing now is really going to be focusing more on what are the solutions. I mean, we've got a good feel, I think, for what the problem is now and the complexity of it. Now we need to flush out a little bit more just what are some feasible solutions for dealing with this.

Mrs. CHENOWETH. Well, I want to thank you very much for your valuable testimony. We will be presenting more questions to you in writing, and as you know, the record remains open for a certain period of time, and we'll look forward to receiving those answers. I also want to thank you very much for the visuals that you had. Let me commend you on that video, too. That was gripping.

So, with that I will dismiss this panel——

Mr. HILL. Thank you, Madam Chairman.

Mrs. CHENOWETH [continuing]. And we'll recognize the second panel. Our second panel consists of Mr. Neil Sampson. He's president of the Sampson Group, Inc. in Alexandria, Virginia; Mr. Gordon Ross of Coos County in Coos Bay. He's County Commissioner in Coquille, Oregon, and Earl Marcellus, Chelan county commissioner of Wenatchee, Washington. And I also would like to recognize Congressman Doc Hastings, who will be joining our panel. Congressman Hastings, we'll go out of order and ask you to introduce Commissioner Marcellus.

Mr. HASTINGS. Well, Madam Chairman, thank you very much for giving me this opportunity. I wanted to take some time and come over and introduce to you one of my constituents, Commissioner Earl Marcellus, from Chelan County in Wenatchee. Earl represents—he is a commissioner in a county that I think in excess of 75 percent of the land is owned by the Federal Government, and a big part of that, obviously, is the Forest Service, so that alone, I think, should qualify him as far as his remarks are concerned as knowing the subject.

Prior to his getting into public service, he was a forester by trade, and so he has an understanding from the standpoint of working in the forest and with the forest lands as having some knowledge on this. So, I just wanted to take some time here today, and thank you for allowing me to introduce my colleague, Earl Marcellus. He represents the area in Chelan County. And by the way, we divide our counties into districts, and his district is the most heavily forested of the districts in Chelan County, and I think he represents his constituents very, very well, and I'm pleased to be here to introduce you to him.

Mr. MARCELLUS. Thank you, if I may, Madam Chair, on that warm welcome here in Washington, DC. I appreciate it. I'm honored to have you introduce me, Doctor—Doc.

Mrs. CHENOWETH. Thank you, Congressman, and panel, with that, I'd like to recognize Commissioner Marcellus for his testimony.

Well, wait a minute. Before we do that, we need to administer the oath, and I wonder if you might stand and raise your hand to the square.

[Witnesses sworn.]

Mrs. CHENOWETH. Mr. Marcellus.

STATEMENT OF EARL MARCELLUS, CHELAN COUNTY COMMISSIONER, WENATCHEE, WASHINGTON

Mr. MARCELLUS. Thank you. I am Chelan County Commissioner, Earl Marcellus, and on behalf of our three-member board, I want to thank you for this opportunity to discuss our forest health problems and suggest solutions.

First, a few facts about Chelan County. The eastern border follows the Columbia River where the arid environment creates rangeland conditions. The western border extends to the crest of the Cascade Mountain range, where forest type ranges from Douglas fir to late successional hemlock/cedar species.

Our population is approximately 63,000, and the ownership of our land base is only—less than 12 percent is privately owned, and more than 88 percent controlled by government entities, primarily the U.S. Forest Service.

With due respect to the Congressmen who will hear and read my testimony, I would like to make a tongue-in-cheek, but pointed statement. It appears that the perception of many from the Potomac is that the U.S. Forest Service and BLM are doing an excellent scientifically based job of managing our national forests in the Western States. That perception, however, is just as incorrect as the perception of those in the western States who believe that Washington, DC is the workfree drug place of America.

The fact of the matter is, a crisis was brewing in the early 1990's because the health of our forests was in decline, and no active legitimate effort by the U.S. Forest Service was being made to harvest the timber that was dead and dying from insects, disease, and drought. Then, in late July 1994, that brewing crisis blew up into an absolute disaster when a lightning storm moved through our county.

Seventy million dollars later, the fires were suppressed, but only after the loss of 200,000 acres of valuable watershed, wildlife habitat, and approximately 1 billion board feet of timber. To date, rehabilitation costs have surpassed $20 million, yet less than 10 percent of the burned timber was ever salvaged on Federal lands, resulting in the needless loss of revenue and resource utilization.

These losses do not take into account the tremendous personal and financial hardships experienced by the citizens and businesses throughout our county because of highway closures, and the smoke-filled air keeping the tourists from visiting, as well as the loss of homes and other properties by our citizens.

The tragic fact is the following two avoidable contributors led to much of these devastating losses. One, the U.S. Forest Service obviously had a let-it-burn policy, at least for the first 3 days during which time the initial manageable fires turned into dangerous project fires with no budget constraints. Two, the U.S. Forest Service has abandoned the proven scientifically based traditional forest management practices that in the past have controlled forest health problems through early treatment of insects, diseases, and overstocking.

When the Forest Service supervisors and district managers are challenged about their management practices, they avoid discussing the merits of the issue and simply state they are following the laws established by Congress. I appeal to you to review the current laws and policies which are having a devastating effect on the health of our forests, as well as our communities, and then establish laws and allow only regulatory policy that is based on sound, verifiable, peer-reviewed scientific data. Congress must weigh lightly and guardedly the environmental rhetoric and computer modeling, which too often simply reflects the bias of a bureaucrat at the keyboard.

Specifically, Congress should consider at a minimum the following points. One, grant the U.S. Forest Service the authority to begin prompt removal of dead or dying trees of all species and all sizes, not just the small trees. Two, require the Forest Service and BLM to designate forest health emergency in high-risk areas and apply necessary remedial management activities. Three, provide for expedited processes for complying with environmental activities, laws, and regulations. Four, limit judicial review and prohibit frivolous appeals, and, five, require pro-active management activities aimed at enhancing forest health to be included in the planning process of the U.S. Forest Service.

In closing, I would say I am aware that those in Congress who agree with my assessment of the Forest Health problems and their solutions will meet with opposition from fellow Congressmen and the current administration. However, the signers of the Declaration of Independence faced much greater opposition when they mutually pledged to each other their lives, their fortunes, and their sacred honor. I sincerely believe we must look backward if we are going to move forward in salvaging not only our forests, but our beloved republic.

Thank you very much.

[The prepared statement of Mr. Marcellus may be found at end of hearing.]

Mrs. CHENOWETH. Thank you very much, Commissioner. That was outstanding.

And I'm very pleased now to recognize Commissioner Gordon Ross, from Coos County in Oregon. I think Coos County, and Coos Bay, especially, vies for one of the most beautiful places in the world. With that, Commissioner Ross.

STATEMENT OF GORDON ROSS, COOS COUNTY COMMISSIONER, COQUILLE, OREGON

Mr. ROSS. Thank you, Chairman Chenoweth, members of the panel. And thank you for those kind words about Coos County; we like to say a lot of nice things about it.

The area that I want to be speaking to you about today is the area that Mr. Hill did not speak about, and that is the Douglas fir region. It was the white area up in the Pacific Northwest that wasn't included in his talk, but it was formed by catastrophic events, catastrophic fire.

Douglas fir trees will not grow in the open; they're not shade tolerant. And so every acre of the Pacific Northwest has a catastrophic fire history, and because the people who formed the FEMAT report—didn't know as much about that history as others, we shaped a Northwest forest plan that will re-enact those historical events if we don't do something to change it.

Fortunately, I bring to you an answer for our problem, and I've put it into your packet, and I would like to submit it into the record now, along with my written testimony, the "Disturbance-Based Ecosystem Approach to Maintaining and Restoring Freshwater Habitats of Salmon." This has been developed with Oregon State University, the U.S. Forest Service, Gordon Reeves from the Forest Service being the lead scientist on this, and I've, along with that, made a pictorial for you of pictures of these disturbances, both the fires, and the results of those fires in history, and the floods and landslides which play a part in the rejuvenating of our streams.

Coos County has done more timber harvesting than any county in Oregon, perpetually since 1855 when the first two mills were established on Coos Bay. San Francisco was the market, and Coos Bay Douglas fir built San Francisco and rebuilt it after the fire and earthquake of 1906.

Today, we continue to harvest more timber than any other county in Oregon, and at the same time we have more Coho salmon in our streams in Coos County than any county in Oregon. As a matter of fact, we have more Coho salmon in our streams in Coos County than all the other 35 counties put together.

Now this was kind of an anomaly to me until the development of this research on disturbance-based ecosystems, because this explains why the landslides and why the storm events following the fire or following the logging, if you may, will rejuvenate these streams with spawning gravel and large woody debris. And I would really like for you to look through the pictorial here because it gives you an opportunity to see what history has done.

On part one you'll see a fire map of just Coos County, but the entire Douglas fir region has a fire history. The next page is a forester's explanation of that. And then you'll see, on page 3, a forest where a fire has not touched it for 350 years, its very few Douglas fir trees standing; it will eventually be a shade-tolerant species.

If you turn the page, on the next two pages you'll see pictures—two pages—will be pictures of the countryside of 1868 that burned 300,000 acres. These are the kinds of fires that formed the Douglas fir region. On an unnumbered page, after page 5, a picture of two stands of Douglas fir timber. The stand in the background grew after the fire of 1868. It was planted by God. The foreground was planted by man, and there isn't a penny's worth of difference between either one of them, and environmentalists can get just as lost in either one, and we'd have to send the cops out to find them.

[Laughter.]

Page 6 shows the growth in 1930, the cruise of marketable timber in Coos County. You'll notice that almost 92 percent was Douglas fir, 2 percent Port Orford cedar, 2.9 spruce, 2.1 hemlock, and so forth. This shows that initially, at the time of settlement, these timbered areas were predominately Douglas fir.

Now we go into part 2, and on page 7 you'll notice a slide of a whole mountainside coming down. Page 7-A are excerpts out of the newspapers back in February of 1890, which is the last time we had slides that where everything that could slide did slide.

Then later we had—in 1995 this piece of information was published and has been out for peer review, and I'm speaking again of the research material. And in 1996 God gave us a divine demonstration back there—17 inches of rain—and so pages 10, 11, and 12 show salmon spawning in gravel held in check by debris slides of that time—these pictures on December 10, just 3 weeks afterwards. And gravel that had never been there in my lifetime—it had been bedrock since the days of the logging splash dams—and so we understand the rejuvenation then, the process of this.

What this gives us is an opportunity now, with the new information under and within the confines of the Northwest Forest Plan, to start doing active management again in these riparian areas of the intermittent streams, and, again, add to the ability of the Forest Service and the Bureau of Land Management to get the red ink out of their budget and also do something for streams and for forest management that is positive.

I'm sorry that I've run out of time, Madame Chair.

[The prepared statement of Mr. Ross may be found at end of hearing.]

Mrs. CHENOWETH. Well, it was very, very interesting testimony, and thank you very much for these very interesting reports. I will study them in-depth.

With that, the Chair is pleased to recognize Mr. Neil Sampson.

STATEMENT OF NEIL SAMPSON, PRESIDENT, THE SAMPSON GROUP, INC., ALEXANDRIA, VIRGINIA

Mr. SAMPSON. Thank you, Madam Chairman. I come before the Committee today with mixed feelings. In 1992 I testified as follows: "It's time to get beyond business as usual on many of the forests in the Inland West because the risks of major environmental economic and social disaster are growing, and the actions taken so far are not even beginning to keep up with the worsening situation."

You know, that statement stands today. I don't know whether to feel decent because we had it right then or to feel bad because we haven't done a whole lot with that information. The study that was reviewed today by GAO doesn't add a lot to what we knew in 1992. It puts detail on; I hope it adds credibility. And I hope it gets some action, because since the day I gave that statement we've burned about 12 million acres in the inland West, and spent about $2 billion. On the Boise National Forest where I was doing most of the work to research this situation, we've burned about 300,000 acres, about 25 percent of the Ponderosa pine forest. We've burned it at heats that suggest that those soils are damaged to the extent that the chances of that forest coming back are fairly slim in a lot of places. So it doesn't give us any great pleasure to come here 6 years later and say we're still not getting at it.

On another aspect, in line with the questions that were being asked earlier by Mr. Peterson, I gave copies of "Forest Health in the United States" to the Committee members. And I wanted to call your attention to the fact that we wrote that booklet about forest health in general across the United States.

We identified six factors that we think are changing the underlying structural dynamics and ecological processes in America's forests. They include this dramatically altered fire regime in many places that we've talked about, landscape-level structural simplification, often brought about by efforts to preserve existing forest conditions; forest fragmentation, which is often brought about by the fact that there's more of us dividing up the area among ourselves; introduction of exotic species that crowd out natives; changes in atmospheric, water, and soil chemistry that affect the growth and competition of forest species, and unusually high animal populations, which while they be native, like deer or elk, are really changing the biological dynamics in these systems.

Now I don't have time to discuss those today, and it's not the primary point of the hearing, but I wanted to leave you with a couple of points. First of all, these changes are affecting forests in all parts of America today, and the long-term effects are not known. What we know is that the forests of tomorrow are going to reflect the effect of these pressures, whether they're good or bad.

The other thing is the changes are not happening in isolation. The gentleman from Pennsylvania asked the question about the forests in his area. They are seeing fragmentation, chemical alteration, exotics, and animal irruptings, all happening at the same time. They're not happening one at a time; they're all happening together. Some of the most unnatural forests in America are growing in the State of Pennsylvania today, and that's not cause for comfort.

The other thing is that, as far as we can tell, most of these changes, and the ecological effects, are probably unprecedented. We don't have any sense that this kind of thing has happened before. The forests of today are not a replica of history, and the ones of tomorrow are not going to follow that pattern either.

There's a policy message in here that I'd like to leave with the Congress. First of all, ignorance about this isn't comforting. We don't know a lot about how this is happening, and the only way we're going to learn is a vastly increased level of forest ecological research, both public and private, to understand the current dynamics and the potential changes that are affecting these forests.

And the second message is the one you discussed earlier: it is my position that increased management, not just watching and waiting, offers the best opportunity to help these forests cope with these kinds of stresses. We caused the stresses. With 270 million Americans, we continue to cause them today, and it's irresponsible to sit back and watch what happens accidentally from those kinds of things, in my judgment.

I'd like to turn now to those fire-dependent forests of the Inland West that we've talked about so many times. We can return those to fire-tolerant conditions, but it's not easy and in many places it's not cheap. I'm going to talk today, as most people do, about the Ponderosa pine forests. We're going to skip over 45 million acres of Pinyon-Juniper forests, Mr. Hansen, which is one of the biggest problems in your State and others in the Southwest, because the lack of markets there are almost absolute in terms of that particular product.

But in the Ponderosa pine forests, people have been demonstrating that there are effective ecological restoration approaches that are positive and that can be done. The problem is, these are not traditional timber harvests and they shouldn't be confused with them. They're very different. As a result of doing it differently a lot of valuable trees are left in the woods because you're trying to restore the structures that the forests need, and a lot of not very valuable stuff is taken out. And as a result, the economics of this operation are often really limited.

But Congress can address some of those problems. Let me give you some ideas. The reason these projections are not economic is the three reasons that I've identified. The first is the material has very little market value. It's either too small or crooked or defective to be used in today's industry. Much of it should be viewed as a challenge of safe disposal—how to get it out of there at the least possible cost. One of the ways to do that is to encourage and support the establishment of biomass-based energy production. We've talked about that before, and there's plenty of record to support the idea.

The second reason the costs are high is because getting small material out of the woods is expensive. It's a lot more expensive than getting big material out of the woods, and there's not much Congress can do about that. It's always going to be costlier to handle small material, but obviously if we want the Forest Service to deal with it, we can change our attitude about below-cost operations because that's what's going to have to happen.

But the third thing is that the costs are driven needlessly high by policies that have been designed for big timber—big log timber harvests. These policies were designed to harvest the timber in Mr. Ross's district, and they are well-fitted to there. But the Forest Service needs to change its policies and practices, to get away from cruising and stumpage sales and log-scaling and other administrative practices designed for big log? They need to go to more use of outside contractors, use weight measurements instead of scaling, adopt end-results performance measures, and carry out multi-year planning to assure people of a long enough supply of material that they can actually invest in treatment facilities.

I see the time is up. I'm going to close by saying that we need to also evaluate the costs of not treating these places. It was testified that treatment cost could be $350 average. I think that's awfully high. We're seeing treatment in prescribed fire in the range of $10 to $12 an acre, and treatment by mechanical thinning that's ranging from $165 an acre profit to $165 an acre loss, depending on the different situations involved.

But even if we lost $250 an acre, the costs of the wildfires that we're seeing now run in the $1,500 to $2,000 range, and in places like Buffalo Creek, Colorado, which I've discussed in my written testimony, they're going to be digging mud out of those water reservoirs for we don't know how many years. It's costing them somewhere between half-a-million to $1 million a year. That's the rate the water users of Denver are paying for that fire. So, let's talk about the costs of not doing something, as well as the costs of doing things when we think about the economics of this.

I thank you for your time and would be happy to answer any questions.

[The prepared statement of Mr. Sampson may be found at end of hearing.]

Mrs. CHENOWETH. Thank you very much, Mr. Sampson, for your valuable testimony.

The Chair recognizes Mr. Hansen for his questioning.

Mr. HANSEN. Madam Chairman, I really don't have any questions for this group. I think it was very interesting to listen to, and I was glancing through their statements as we went through here. Frankly, I'd say I agree with many of these things; I just don't know how you implement them. The four points that the one gentleman brought up were excellent. How to do these things is always the problem. It's how to get it done, you know, and that becomes some very heavy legislative roadblocks.

I would like to come back for the last testimony. I have to be on the floor in 6 minutes, so I'll try and get right back, but thank you for the time, and I thank the gentlemen for their testimony.

Mrs. CHENOWETH. Thank you, Mr. Hansen. The Chair recognizes the gentleman from Washington, Mr. Hastings.

Mr. HASTINGS. I just have two questions I want to followup with to Earl Marcellus. You made five points as to what your suggestions would be. I want to specifically talk about points three and four. Point three, "provide for expedited process for complying with environmental activities, laws, and regulations," and four, "limit judicial review and prohibit frivolous appeals."

I made the assumption that you came to both of these conclusions and suggestions both from being in the private sector and probably, more recently, in the public sector as commissioner. If I'm right on that, let me know, but give me an idea in either case of how you arrived at that and maybe some real-life examples that lead you to these conclusions.

Mr. MARCELLUS. Well, let me just use, maybe, an analogous example. We've got hundreds of miles of hiking trails in our county into the beautiful Cascade Mountains, and last year the Forest Service was totally unable to open these trails in the wilderness area portions with hand equipment. They spent tens of thousands of dollars doing an environmental assessment as to whether they should allow chainsaws to go in and open these trails, and in the private sector and in the good old days with the Forest Service, we would have moved in and just gotten the job done.

There's just simply too many regulatory hoops for the Forest Service to jump through to get the job done. And like I said in my testimony, they tend to give "We the people" the answer, "Well, it's Congress' fault. We're just simply following the laws established by Congress and by the regulatory agencies that you have oversight."

Mr. HASTINGS. Let me just followup then. After the burn in 1994, only about 10 percent—or maybe it was a little big higher—of that was salvageable, or was salvaged, I should say. What do you—I mean, are the reasons for that which you describe here by examples in three and four?

Mr. MARCELLUS. Well, let me use that question to state a quote. It goes as follows: "He has erected a multitude of new offices and sent hither swarms of officers to harass our people and eat out their substance." Does that not sound like the regulatory bureaucracy that we have today? That quote comes directly out of the Declaration of Independence, and it just seems that we have come full circle in allowing what I like to refer to as a fourth branch of government to evolve in this country—the regulatory agencies—and the Forest Service's hands are bound.

And I have to be very frank and honest with you today. It appears to me and many others that many of those who have the green agenda have gone to work for the Forest Service, and a lot of the good timber people and the people who really know how to fight fires have become so frustrated that they have voluntarily retired or taken early retirement. It's really most unfortunate.

Mr. HASTINGS. Well, the last thing I would say is, to briefly corroborate what you're saying, I had a town hall meeting up—not in your county, but in Okanogan County right above that, and I heard essentially the same thing from retired members of the Forest Service that led to the same conclusions that you came to. I think that that—I think, Madam Chairman, that is happening.

Thank you very much for allowing me to sit here.

Mrs. CHENOWETH. Thank you, Mr. Hastings. Mr. Ross, did I understand you to say in your testimony—I either read it or I heard you say—that your county manages some forest lands?

Mr. ROSS. Yes, our county manages 15,000 acres of forest land, and we do it and we return a profit to the taxpayer. In fact, 93 percent of our timber sale value is returned to the taxpayer in the form of county services. We operate our forest on 7 percent. Only the Federal Government can be given timberland and lose money managing it.

Mrs. CHENOWETH. Can you explain again what the opportunities are to apply the new research that you were talking about? First, I'd like for you to tell us in more detail how landslides can really help the fisheries, and then I'd like you to address how this new research, in light of the Northwest Forest Plan and the President's record of decision, how this applies.

Mr. ROSS. Thank you, Madam Chair. This research has described—or, it has been research looking at the evolution of our streams, and the streams that within the last four or five decades have had major catastrophic events, major landslides, have adequate spawning gravel and large, woody debris to hold that gravel in place. The ones where it's been hundreds of years are the ones that maybe look the most pleasant to the eye, but are actually the most barren of fish and fish habitat.

Now the opportunity lies within the Northwest Forest Plan's intermittent stream buffers, those buffers that Jerry Franklin said the lizard people put in, that got doubled in size when they got to Washington and then enacted into almost stone when the record of decision was handed down by Judge Dwyer.

However, even in the record of decision, it shows that those were interim buffers until the watershed analysis could be done. Those are the buffers that when we got right out on the landscape, we found they overlapped. It just took away from the matrix areas where the active forestry was to be practiced and buffered it from anything happening.

So the opportunity now, since the watershed analysis has been done, is to apply this new technology—or, rather, this new research and the technology that this will lead to—to harvesting and doing active management in those buffered areas as we can enter into them and then, finally, over the whole landscape as the new decadeal plan is developed. I think it's a great opportunity to apply science, a science that has been peer-reviewed, and I will be presenting this at 11 o'clock on Thursday to Mike Dombeck.

Mrs. CHENOWETH. Gosh, that's very interesting. I'd like to ask Mr. Sampson, What impact is the current Forest Service emphasis on prescribed fire likely to have, in your opinion?

Mr. SAMPSON. Well, they're certainly ramping-up their efforts in prescribed fire, and they're doing it over a lot broader area and a lot more cheaply. The problem that I think you're going to see was touched on briefly by the GAO. Because the target is acres, the incentives are to go get what you can get, rather than what's really the highest priority.

And because the tool is prescribed fire, some of the highest priority areas are really dangerous to get. They're too close to habitation, there are too many houses around—it's just too difficult. They're in highly populated areas, and the smoke problem is very real and very much of a restriction.

So the problem with going at the large situation that exists with prescribed fire as the main approach is that it tends to lead you away from the highest priority and most dangerous and difficult areas.

Mrs. CHENOWETH. How important are the current restrictions on smoke and air pollution?

Mr. SAMPSON. Well, they have not stopped very much yet, it doesn't appear.

Mrs. CHENOWETH. No.

Mr. SAMPSON. We can't find a lot of evidence yet that they have limited the use of prescribed fire. When you find what limits prescribed fire in the West today, you'll find a lack of staff trained in the techniques. You'll find a limited number of days in a year when you can safely burn anything, between when it's too dry to be safe and too wet to do it at all, and you'll find these large areas involved.

Smoke is important. There are very real health hazards caused by smoke, and in those populated areas it's going to get worse and worse. But, so far pollution regulations haven't stopped very much because most of the burning has been back away from that populated area.

Mrs. CHENOWETH. Mr. Sampson, your four points that you concluded your testimony are very, very good, but the fact is, is it not true that actually getting in and mechanically cleaning up the understory and the fuel load and thinning out actually can still have a value in the marketplace, whereby prescribed burning, really, simply costs the taxpayers money? What is your opinion on that?

Mr. SAMPSON. Well, I don't think you should put them at opposite poles like that. I think each are appropriate in their own place. The problem with the products that need to be taken out is very local. In Cascade, Idaho, there's a new mill that takes material down to a 4-inch top, positions it with computers, and economically produces lumber out of 4-inch material. That changes the definition of a saw log dramatically from what we've seen in many other areas. But what can happen in that mill in Cascade can't happen anywhere else in that region because they're the only ones that have invested in that.

I was in Colorado yesterday doing a project where there's no industry left at all, so nothing is a saw log. It doesn't matter what its size or quality. There's no such thing as commercial timber opportunity of any kind when there's no industry left to take it out of the woods and do something with it.

So, this is very localized in nature. In a lot of these communities, people are making really fine use of this small stuff. We've got trees out there 5 inches in diameter that are 125 years old. They've been suppressed; they're sitting there at 5 and 6 inches. They are some of the highest quality wood for beams and other products that is available. We've just got to get them into that kind of use.

So, there's a lot of opportunity. It's almost all non-traditional. We've got to deal with it by weight instead of scaling, because if you try to scale one of these forests that's full of 4-inch, 5-inch and 6-inch stems, with 1,200 of them to the acre, you just go crazy with your costs. There are ways to do it, but we've got to get away from the traditional timber harvest mentality and go to a forest restoration mentality, administratively. That was the point I was trying to get at.

Mrs. CHENOWETH. Well, let me take another run at this.

Mr. SAMPSON. OK.

Mrs. CHENOWETH. Prescribed fire—does that add anything to the timber fund?

Mr. SAMPSON. It really does. You've got forests out there, Madam Chairman, that were maintained historically by fire and that need fire once in a while. That prescribed fire might be slash burning after a mechanical treatment. It might be prescribed fire before or after treatment; that's not the case. You don't have anything else in your tool kit that recycles nutrients and that provides the kind of ecological impact that fire does, and so putting fire back in that landscape safely is a really important part of this that shouldn't just be done as an either/or—we're either going to do this or that. We need to do a lot of all of that.

Mrs. CHENOWETH. Now with prescribed burning, is what you're telling the Committee that in the long run, given that there will be some sort of mechanical harvesting of some sort down the pike in the long run, then that later on adds to the timber fund?

Mr. SAMPSON. It's both now and later. There's a huge bulge of material out there now——

Mrs. CHENOWETH. Right.

Mr. SAMPSON [continuing]. from 50 to 75 years, and a lot of that has to come out before prescribed fire can be re-introduced. But in the long run, a management regime that does not totally exclude fire is probably going to create healthier and more productive forests, than one that tries to totally exclude it.

Mrs. CHENOWETH. Let me take my third run at this. Within a period of 10 years' prescribed fire, would that add to the treasury in the timber fund?

Mr. SAMPSON. No.

Mrs. CHENOWETH. OK.

Mr. SAMPSON. Not in the short term. It won't in the short term, and in the short term the bulge of material that's on much of that land, as we've said earlier, precludes using prescribed fire in many areas.

Mrs. CHENOWETH. But with a change in policy within 10 years—if, you know, given that the marketplace has changed and given the fact that some mills are going down to the 4-inch diameter, given the fact that even in Idaho, and I'm sure many of the agricultural States, they're not now talking about timbers made out of straw. Given the fact that the market will respond to the demand that's out there, if we went in with mechanical means we could then begin to buildup the timber fund—not with straw, but with the small stuff, as well as the larger diameter timber. So that was my original question.

Mr. SAMPSON. Well, I honestly have to tell you that for the Congress to think that it's going to build a timber fund with a lot of these projects—I'm not as optimistic about that as I believe your position is. What I think you're doing is reducing the damage accounts greatly and, hopefully, bringing the timber fund into it neutrally. I think you could make enough money to pay for the treatment. I don't think we're going to get rich——

Mrs. CHENOWETH. OK; so this answer that you've just given me is based on your second premise, that to go in and restore the land will be expensive, and we're going to have to re-order our thinking with regards to below-cost timber sales.

Mr. SAMPSON. But in the long run, that's the pathway back to healthy forests in that region.

Mrs. CHENOWETH. I think so. Very good. Thank you, Mr. Sampson. Mr. Marcellus?

Mr. MARCELLUS. Yes, Madam Chairman, if I may add to the answer of Mr. Sampson in light of your question of prescribed burning, I think he made it fairly clear that prescribed burning can be after harvesting operations to burn the slash, which was a historical management tool of the Forest Service and private industry. And I think what you were asking, if prescribed burning was done without harvest, would that give a return to the coffers? And in the short term, no; it's costly to go out there and do that sort of thing.

But if it's done successfully—and I'm not a proponent of prescribed burning when there is the opportunity to get out there and do it mechanically or cost-effectively by manpower and do the thinning of the overstocked stands. I wish I'd have brought a little pine section that I cutoff of a tree that I thinned out on my own home just outside of my house, years ago, and it was a Ponderosa pine tree which isn't known to respond that well to release.

And that's what we're talking about, is getting in there and dealing with the overstocked stands to give more room for growth, more ability to get moisture and nutrients. And it will bring a return because your trees that are left behind are more insect-resistant and fire-resistant, and they will grow faster and will get more growth per acre in 20 years or more return. So we do have some—but I think in our county and throughout the West, there are stands that are in great need of traditional management practices that have been cast away that will generate returns today.

Mrs. CHENOWETH. Very interesting. I have two bills out there that we're hoping, somehow, will be successful, and they've addressed what Mr. Sampson and all three of you, actually, have talked about—the Hazardous Fuels Reduction Act, which cleans up the area between the urban wildland interface, and the video that we saw GAO show, my bill would directly address that.

We saw catastrophic fires in Florida this year affecting people's homes. We lost homes—thank goodness we didn't lose any lives, but the year before that we lost a large number of homes and some lives in California because we have not addressed that urban-rural interface, and we must do so.

And then the NEPA parody bill, which will target certain forests that are in dire shape, and hopefully will be able to give the Forest Service a tool to get in and start working on those areas, which, by the way, every single one of them is a red area that was shown on Mr. Hill's poster boards.

So with that, I've learned a lot from you, and I want to thank all three of you for being here. Two of you have come a long way. And it's always a privilege to be able to hear Mr. Sampson, and I appreciate this book, the "Forest Health in the United States" by R. Neil Sampson and Lester DeCoster. I've read it once and am going to look forward to reading it again. Thank you very much.

And with that, this panel is excused.

Mrs. CHENOWETH. The Chair now recognizes Janice McDougle as the next panelist. Ms. McDougle has faced this Committee many, many times, and she is the Associate Deputy Chief for State and Private Forestry, Forest Service, U.S. Department of Agriculture in Washington, DC, and she is accompanied by Mr. Harry Croft, Acting Director, Fire and Aviation Management of Forest Service, USDA in Washington, DC.

So, Ms. McDougle, I wonder if you could take one of the center seats, maybe over on the other—that's good. Good, and now I wonder if you could both stand and raise your hand to the square.

[Witnesses sworn.]

Ms. McDougle, please proceed.

STATEMENT OF JANICE McDOUGLE, ASSOCIATE DEPUTY CHIEF FOR STATE AND PRIVATE FORESTRY, FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE, WASHINGTON, DC; ACCOMPANIED BY HARRY CROFT, ACTING DIRECTOR, FIRE AND AVIATION MANAGEMENT, FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE, WASHINGTON, DC

Ms. MCDOUGLE. Good afternoon, Madam Chairman, members of the Subcommittee. I appreciate the opportunity to join you to discuss forest health and to hear the GAO's preliminary observations concerning forest health and fuels. The Forest Service is looking forward to working with GAO to identify ways to continually improve forest health conditions.

We estimate that approximately 39 million acres of National Forest System lands, primarily in the inland West and the Atlantic coastal States are at high risk from damaging, high-intensity wildland fire. Many of these stands are dense and over-crowded, with high mortality rates due to bark beetle or other insect outbreaks. It is important that the public understand that fire is part of a natural ecological cycle, and over a long enough period, all forests will eventually burn.

The exclusion of wildland fire for the last 100 years has had a profound influence on the composition and structure of natural fuel conditions and the function of those ecosystems where frequent and low-intensity fires historically occurred. These conditions are contributing to the growing severity of the fire situation throughout the country. Unless we address these changed conditions, the fire severity situation will continue to grow, threatening the health of watersheds and larger ecosystems.

In addition to changes in natural hazardous fuels, demographic changes of people moving from urban areas to rural areas have resulted in an increasingly complex mix of people, infrastructure, and forests, which is known as the wildland urban interface.

Throughout the United States, it is more and more common to see homes and other types of structures being built in wildland environments. Because of their location, these structures are extremely vulnerable to fire, should a wildland fire occur in the surrounding area. The trend is resulting in a volatile situation that must be addressed.

This is as much a forest health concern as a fuels concern. We are addressing this problem at the most fundamental level. We have embarked on an aggressive program to use fire in a more natural ecological role to reduce fuels hazards and to help protect forest ecosystems from the ravages of high-intensity fires and epidemics by insect attacks.

Other tools we are using to improve ecosystem conditions include timber sales, thinning, and other fuel reduction methods, including mechanical treatments. However, we will not treat, nor is it practical to treat, all of the affected acreage.

Therefore, we are prioritizing areas to be treated first, to address those areas of greatest risk and potential for damage, such as wildland urban interface areas, critical watersheds, and sensitive wildlife habitats. This strategy will focus available funds and capabilities where they will have the most effect. We are creating a management environment that encourages the treatment of those priority areas through budget allocation and direction to local managers.

To help understand the nature of the issues, we are currently implementing the Joint Fire Science Plan as provided in the Conference Committee report for the 1998 Interior Appropriations Act. The four principal purposes of the plan are to complete a national program for fuels inventory and mapping, evaluation of fuels treatment, scheduling of treatments, monitoring and evaluation. Projects have already been identified and grants and contracts issued to help us better manage the hazardous fuel reductions program.

Clearly, the challenges we face in improving forest health and reducing fire risk are great. By restoring fire to its natural role in ecosystems, we can improve the health of our Nation's forests, while at the same time reducing their susceptibility to catastrophic fire.

Thank you, Madam Chairman. I have summarized my remarks, and we will enter into the full record our testimony. I'm prepared to answer any questions that you may have at this time.

[The prepared statement of Ms. McDougle may be found at end of hearing.]

Mrs. CHENOWETH. Thank you, Ms. McDougle. The GAO, in their testimony, indicated that the agency lacks a strategic plan that will deal with these critical acres that he indicated on his poster board. You indicated that you will focus first on certain critical watershed areas, urban-rural wildlands interface, and certain wildlife habitat areas, especially for critical wildlife habitat.

Does that comport with what Mr. Hill said, in terms of the fact that there are 10 million acres left with absolutely no plan whatsoever or no long or short range plan to do anything with those acres?

Ms. MCDOUGLE. Well, I thought the remarks were interesting in that it was suggested that we have a national plan for addressing these issues, and I'm not sure that we believe that that is indeed required. Our efforts in this regard are not just the Forest Service's; they are all the land management agencies who have collectively decided what the priorities are.

Our activities in terms of reducing fuels—it's not done out of the Washington office. It's not done nationally; it's done by the units, and as they aggregate, we can tell how much that they feel they are capable of getting done in any given year, and it's an estimate. Sometimes they do more, like this year. I think we exceeded our targets during this Fiscal Year, and so these are estimates that are field-driven. And in terms of how they're going to go about doing it, these are also their calls, based on—on the ground conditions.

Mrs. CHENOWETH. Well, given that we're talking about 39 million acres that are in a very, very, very serious catastrophic condition—39 million acres. You'll agree to that, right?

Ms. MCDOUGLE. That's the best estimate we have, and we are validating those numbers right now.

Mrs. CHENOWETH. OK. That's about one-third of the entire base of our national forests. How did it happen that the agency let one-third of its entire resource get into this kind of condition?

Ms. McDOUGLE. Like I said, it's taken over 100 years for this to happen, and it's going to take some time to do it. And as Mr. Sampson said earlier in his testimony, it isn't any one thing. It isn't totally within the agency's control, and, frankly, it hasn't been a priority in Congress. The priority has been focused on the timber program, and this hasn't been one of those issues that has been a priority on the Hill.

We did—just to get the fuels program some attention—request and receive for the 1998 appropriation a specific budget identify for fuels because we weren't able to get—we weren't able to build a program. We received support from the Congress in 1998, and as best I can tell, we will in 1999. We spent $50 million in 1998, and we requested in the President's budget $65 million. This is an evolving effort of the Forest Service to focus attention on the fuels issue.

Mrs. CHENOWETH. Now the President asked for $65 million specifically for what?

Ms. McDOUGLE. Fuels.

Mrs. CHENOWETH. Fuels. In what way?

Ms. McDOUGLE. Well, for fuels management, and in terms of strictly devoted to reducing the fuels. You know, the methods are not—there are a whole array of tools to be used, but they all go toward reducing the fuels.

Mrs. CHENOWETH. I think I probably share with you the fact that we can't go back and can't keep asking ourselves, "Why?" We have a difference in opinion as to why 39 million acres are in a situation that is considered code red. But I want you to know, Ms. McDougle, Congress is concerned, and there is a lot of expression of concern on the Hill.

I get the stuffing kicked out of me, and other western Members get the stuffing kicked out of them, because we're not seeing a return to the timber account. And the environmental organizations and their publications are replete with the fact that we can't manage sufficiently to do anything but have low-cost timber sales.

So, yes, you need to know at your level and at every level that Congress is very concerned and very concerned that we're able to return money back to our timber account. Nobody is more uncomfortable with the fact that we are having below-cost timber sales while we're seeing a deterioration in the forest system itself than I am.

So, what can you provide the Committee in terms of maps and tables indicating the current fuel loads on national forests, by State and by watershed, and the levels of risk of catastrophic fire that they face in relation to some explained scales of risk and hazards to resources and to people? I'd like for you to be able to do that.

And, furthermore, I wanted to ask you—you mentioned the fact that you're still involved in mapping. Isn't a lot of the mapping being done by aircraft or by satellite, in terms of the intensity of fuels in the forest?

Ms. McDOUGLE. We're doing GIS modeling. Regarding when will the maps be available, I think I mentioned to you at a previous hearing that we will have our Fire: Forests at Risk map available this fall. I learned Friday that we should have it early November. We have a map, and our people are currently validating a map—

a new map that shows the wildland urban interface areas that are of great concern, and we're updating our insect and disease map.

So I think that in the next month or two, we will have a pretty darned good picture of all of these issues to make some assumptions from, especially in terms of focusing priorities on work.

Mrs. CHENOWETH. When you prepare projects to improve forest conditions, such as timber sales, thinnings, mechanical field treatments, and/or prescribed burning, what types of environmental analyses are required?

Mr. CROFT. Madam Chairman?

Mrs. CHENOWETH. Yes.

Mr. CROFT. I think that would be based on the complexity of the project at hand. I don't know first-hand knowledge of perhaps what you are referring to. At one time—I have been in the field for years. I've done timber sales, I've done thinnings, and I've fought fire. I just want you to understand that. When I first started out, I could do an EA for a 20 million board feet timber sale. Today you require an EIS. It clearly has changed in terms of what's required.

On fuels projects, it's all depending on where you are and what the probable impacts are. In the southeast, you could do a categoric exclusion for a 1,000-acre prescribed fire. If you're in the Northwest, it may be only 20 acres, so it depends on the nature of the project and the probable impacts of that project.

Mrs. CHENOWETH. Interesting. Well, Ms. McDougle or Mr. Croft, I've seen a proposal establishing an arbitrary acreage limit for thinnings and other activities that require an EIS, based on which eco-region the project is located in, so if it's located in the southeast it might have another arbitrary requirement than in the Northwest. It appears that the proposal would greatly increase the number of EIS's required for such vegetation management proposals, and given the catastrophic conditions that we have out there, I'm very concerned about that. Would one of you address that?

Mr. CROFT. I think you might be referring to the draft regulations?

Mrs. CHENOWETH. Yes, the draft regulations.

Mr. CROFT. I've only just seen those, and I just have seen them and have not had that chance to look at them. I know at first glance we did have some concerns, and we are talking with the land management planning people right now about those concerns, I think for the same reasons.

Mrs. CHENOWETH. Thank you. I would very much appreciate your staying in close touch with my staff on this. I'm very concerned about it, given the catastrophic situations that we have. I do think the National Forest Management Act does allow for the supervisor to be able to use his own experience and discretion in making those decisions, and I don't want to take that away from him. So, I would appreciate your focus on this.

As you know, I have a lot more questions, but my time has expired, and I will excuse you right now, but I will be submitting more questions for you to answer. And this record will remain open for 5—or for 10 working days, should you wish to supplement your testimony with anything. And I would appreciate your answering our questions within 30 days—30 calendar days.

[The information referred to may be found at end of hearing.]

Mrs. CHENOWETH. So with that, again, I want to thank the panels for being here and for your valuable testimony, and with that, this hearing is adjourned.

[Whereupon, at 3:45 p.m., the Subcommittee adjourned subject to the call of the Chair.]

[Additional material submitted for the record follows.]

STATEMENT OF EARL L. MARCELLUS, CHELAN COUNTY COURTHOUSE, WENATCHEE, WASHINGTON

Dear Committee members:

I am Chelan County Commissioner Earl Marcellus and on behalf of our three member board I want to thank you for this opportunity to discuss our forest health problems and suggest solutions.

First a few facts about Chelan County:

- The eastern border follows the Columbia River where the arid environment creates rangeland conditions.
- The western border extends to the crest of the Cascade Mountain range where the forest type ranges from Douglas fir to late successional hemlock/cedar species.
- Population—63,000
- Percent "ownership"
  —less than 12 percent privately owned
  —88+ percent controlled by government (primarily the U.S. Forest Service).
- Obviously Chelan County is a rural, timber dependent county.

With due respect to the Congressmen who will hear and/or read my testimony I would like to make a tongue in cheek but pointed statement. It appears that the perception of many from the Potomac is that the U.S. Forest Service and Bureau of Land Management (B.L.M.) are doing an excellent, scientifically based job of managing our national forests in the Western states. That perception, however, is just as incorrect as the perception of those in the western states who believe Washington, DC is the "workfree drug place of America."

The fact of the matter is, a crisis was brewing in the early 1990's because the health of our forests were in decline and no active, legitimate effort was being made by the U.S. Forest Service to harvest the timber that was dead and dying from insects, disease, and drought. Then, in late July 1994 that brewing crisis blew up into an absolute disaster when a lightning storm moved through our county.

Seventy (70) million dollars later the fires were suppressed but only after the loss of 200 thousand acres of valuable watershed and wildlife habitat and approximately 1 billion board feet of timber. To date, rehabilitation costs have surpassed 20 million dollars yet less than 10 percent of the burned timber was ever salvaged on Federal lands resulting in the needless loss of revenue and resource utilization. These losses do not take into account the tremendous personal and financial hardships experienced by the citizens and businesses throughout our county because of highway closures and the smoke filled air keeping tourists from visiting as well as the loss of homes and other properties by our citizens.

The tragic fact is the following two *avoidable* contributors led to much of these devastating losses:

1. The U.S. Forest Service obviously had a "let burn policy," at least for the first 3 days during which time the initial manageable fires turned into dangerous project size fires (no budget constraints).
2. The U.S. Forest Service has abandoned the proven, scientifically based, traditional forest management practices that in the past have controlled forest health problems through early treatment of insects, diseases and overstocking.

When the Forest Service supervisors and district rangers are challenged about their management practices they avoid discussing the merits of the issues and simply state they are following the laws established by Congress. I appeal to you to review the current laws and policies which are having a devastating effect on the health of our forests as well as our communities. And then establish laws and allow only regulatory policy that is based on sound, verifiable, peer-reviewed science. Congress must weigh lightly and guardedly the environmental rhetoric and computer modeling which too often simply reflects the bias of the bureaucrat at the keyboard.

Specifically, Congress should consider at a minimum the following points:

1. Grant the U.S. Forest Service the authority to begin the prompt removal of dead or dying trees of all species and sizes (not just the small trees).
2. Require the Forest Service and B.L.M. to designate forest health emergency and high-risk areas and apply necessary remedial management activities.
3. Provide for expedited processes for complying with environmental activities, laws and regulations.
4. Limit judicial review and prohibit frivolous appeals.
5. Require proactive management activities aimed at enhancing forest health be included in the planning process of the U.S. Forest Service.

I am aware that those in Congress who agree with my assessment of forest health problems and their solutions will meet with opposition from fellow Congressmen and the current administration. However, the signers of the Declaration of Independence faced much greater opposition when they mutually pledged to each other their lives, their fortunes, and their sacred honor. I sincerely believe we must look backwards if we are going to move forward in salvaging not only our forests but our beloved Republic.

STATEMENT OF GORDON ROSS, COMMISSIONER FOR COOS COUNTY, OREGON

Thank you for the opportunity to speak to you on the issue of forest health in the Northwest. I am especially thankful to have the opportunity to extol the virtues of the Douglas Fir Region where we have some of the most productive forest land and anadromous streams in the world and particularly Coos County, where we have consistently, since 1855, harvested more timber than any county in Oregon and at the same time have more Coho salmon than all other counties combined. This to me was an anomaly until the work on "Disturbance Based Ecosystems" was published in the fall of 1995 and then God gave us a divine demonstration on November 18, 1996 and we all saw first hand the part that slides play in rejuvenating our streams with spawning gravel and large woody debris. I wish to share with you two things today. #1, the science and #2 the opportunity it presents.

(1) Both the Douglas Fir forests of the region and the anadromous streams are ecosystems based in disturbances, mainly fire and flood.

Gifford Pinchot, after three years on the Olympic Peninsula stated "I have not seen a Douglas Fir seedling growing under the canopy or an opening that was not filled with them." Fire was the principle stand replacement event in nature. While its frequency varied, recent research by Bob Zybach indicates a frequency greater than formerly believed. The fact that an early cruise of marketable timber in Coos County shows 92 percent to be Douglas Fir and only 8 percent shade tolerant species backs up this research. I must comment, the meager amount of regeneration harvest embodied in the N.W.F.P. will result in a much different mosaic than existed in pre-settlement times.

The flood events that followed the fires will still occur but with passive management they will be less dynamic in their restoration of our streams. In short, active management is needed to replicate the disturbances that shaped the Douglas Fir region. With active management, disturbances can be located, timed and controlled to maximize the beneficial impacts on our streams, while minimizing any adverse effects. A happy by-product of this approach is utilization of our timber resources in a way that *supports our local communities.*

(2) What are the opportunities this newly articulated science provides under the N.W.F.P. and R.O.D?

(A) In the short term the opportunities lie in the management on the matrix lands within the buffers of the intermittent streams. The current buffers were intended by the N.W.F.P. to be temporary until watershed analyses were completed. Many of the watershed analyses are now complete. The opportunities exist within these buffers for regeneration harvest that would leave large debris that could eventually enhance a fish-bearing stream. The opportunity to leave standing timber that could reach those streams or leave down wood on a harvest unit for that purpose could far better reproduce natural events than passive no touch management. In many cases the large woody debris could be placed in or near streams to speed up natural processes. This approach could be gradually implemented now, without disrupting the N.W.F.P., indeed consistent with the N.W.F.P. expectation that managers would gradually move back into the buffers once watershed review was complete. The BLM resource management plan periodic reviews scheduled for the next two years provide the perfect opportunity to move in this direction.

(B) The long-range opportunity is to apply this science in the next decadal plan across the entire Federal landscape. The timetable is right to begin this historic and scientific approach and extend these principles into the first decadal plan of the 21st century. A new decadal plan is due in 2004. I urge the Federal managers to begin the process now, so we have orderly plan development rather than the slap-dash, hurry-up process that gave us the N.W.F.P.

This information can and must be a turning point in the way Congress and the American consumer view commodity production in the forests of the Northwest. The political decisions that have been made about logging have hinged around the debate over environmental protection vs. commodity production. We have tried to balance, as it were, these issues on a giant set of steelyards, placing on the right side the commodity benefits, jobs, revenues and resources while on the left side clean air, clean water, fish and wildlife resources. We have seen the balance go heavier to the right as the threat of job losses in our rural communities in the Northwest materialized, as revenues dropped for essential services and as the cost of housing rose across America and our balance of trade was adversely impacted by imports.

One by one through science and best management practices, we have also seen the shifting of the other issue from one side to the other. Most wildlife that the average person knows or cares about are benefited by the openings and temporary meadows brought about by a regulated harvest. Last year it was established before this Committee that our air: that the amount of oxygen released into the atmosphere, the amount of carbon fixed in wood fiber by the forest is enhanced by the harvest of mature timber and manufacture of durable goods and the re-growing of new timber stands.

I submit to you, ladies and gentlemen, until this new science on disturbance based ecosystems has been presented the only issue left on the other side of the fulcrum is the health of our streams and our trout and salmon runs and this is no small issue. This issue also embodies the issues of jobs, revenues and resources. But today, I submit to you that the health of not only our forests but also our streams and their runs of salmon and trout and the jobs and food supply connected with those runs will, over the long run, be benefited by commodity production after careful watershed analysis are completed. Today I submit this report into the Congressional record and subsequently into the Library of Congress for the benefit of those decision makers that hold in their hand the destiny of the Northwest, the health of its forests and streams and to a large degree, the availability of affordable housing in America.

I wish you to note this report was published in 1995, it has been published in scientific journals and has been out for scientific peer review for three years. It is not premature to use this information as a basis for decision making.

CC Rocky McVay 9/3

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A Disturbance-Based Ecosystem Approach to Maintaining and Restoring Freshwater Habitats of Evolutionarily Significant Units of Anadromous Salmonids in the Pacific Northwest

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Abstract.—To preserve and recover evolutionarily significant units (ESUs) of anadromous salmonids *Oncorhynchus* spp. in the Pacific Northwest, long-term and short-term ecological processes that create and maintain freshwater habitats must be restored and protected. Aquatic ecosystems throughout the region are dynamic in space and time, and lack of consideration of their dynamic aspects has limited the effectiveness of habitat restoration programs. Riverine–riparian ecosystems used by anadromous salmonids were naturally subjected to periodic catastrophic disturbances, after which they moved through a series of recovery states over periods of decades to centuries. Consequently the landscape was a mosaic of varying habitat conditions, some that were suitable for anadromous salmonids and some that were not. Life history adaptations of salmon, such as straying of adults, movement of juveniles, and high fecundity rates, allowed populations of anadromous salmonids to persist in this dynamic environment. Perspectives gained from natural cycles of disturbance and recovery of the aquatic environment must be incorporated into recovery plans for freshwater habitats. In general, we do not advocate returning to the natural disturbance regime, which may include large-scale catastrophic processes such as stand-replacing wildfires. This may be an impossibility given patterns of human development in the region. We believe that it is more prudent to modify human-imposed disturbance regimes to create and maintain the necessary range of habitat conditions in space (10^3 km) and time (10^1–10^2 years) within and among watersheds across the distributional range of an ESU. An additional component of any recovery plan, which is imperative in the short-term, is the establishment of watershed reserves that contain the best existing habitats and include the most ecologically intact watersheds.

> Biodiversity is not a 'set-aside' issue that can be physically isolated in a few, or even many, reserves. . . . We must see the larger task—stewardship of all the species on all of the landscape with every activity we undertake as human beings—a task without spatial and temporal boundaries. (J. F. Franklin 1993)

Agencies responsible for the development of recovery plans for evolutionarily significant units (ESUs; Waples 1991) of anadromous salmonids *Oncorhynchus* spp. in the Pacific Northwest (PNW) of the United States face difficult tasks. First is the identification of ESUs. Second is the identification of factors that contribute to the decline of a particular ESU. A suite of factors, including habitat loss and degradation, overexploitation in sport and commercial fisheries, variable ocean conditions, and effects of hatchery practices, are responsible for the depressed status of these fish (Nehlsen et al. 1991). The relative importance of each in contributing to the decline of an ESU undoubtedly varies across the region. Any recovery program must address and incorporate consideration of all responsible factors to be successful.

The most common factor associated with declines of anadromous salmonids is habitat degradation, which includes destruction and modification of freshwater and estuarine habitats (Nehlsen et al. 1991; Frissell 1993). Stream and river systems throughout the PNW have been extensively altered by human activities such as agriculture, urbanization, and timber harvest (Bisson et al. 1992). Features of altered ecosystems include changes (generally reductions) in species diversity, changes in species distributions, and losses of habitat types or ecosystem states (Holling 1973; Rapport et al. 1985; Steedman and Regier 1987). Li et al. (1987), Bisson et al. (1992), and Reeves et al. (1993) noted that native salmonid assemblages are simplified in watersheds that have been impacted by various human activities. Native nonsalmonids or introduced species often dominate fish communities in altered ecosystems (Li et al. 1987; Bisson et al. 1992). Habitat degradation is widespread across the region as a result of past and present activities (Bisson et al. 1992; McIntosh et al. 1994). Degradation of terrestrial ecosystems in the PNW (Thomas et al. 1993) and elsewhere (e.g., Wilcove et al. 1986; Rolstad 1991) has resulted in similar changes in terrestrial species assemblages.

Past and many present approaches to management of freshwater habitats of anadromous salmonids have focused on mitigating losses rather than preventing them. This strategy has generally not been successful (Bisson et al. 1992) and habitat loss and degradation continue. Williams et al. (1989) also found that such a strategy failed to halt the decline of habitat quantity and quality for other freshwater fishes. Naturally variable ocean conditions increase the importance of freshwater habitats to anadromous salmonids (Thomas et al. 1993). As a result of this dependence on freshwater habitats and the extensive amount of habitat degradation that has occurred, protection and restoration of upslope and fluvial processes that create and maintain habitats must be an integral component of any recovery program.

Habitat losses may result from human activities that directly destroy habitats or change the long-term dynamics of ecosystems (Rapport et al. 1985; Webb and Thomas 1994). Recent proposals for restoring and protecting habitats of at-risk fishes (e.g., Reeves and Sedell 1992; Thomas et al. 1993; Moyle and Yoshiyama 1994) addressed habitat destruction, primarily through the establishment of watershed-level reserves in which human impacts would be minimized, as advocated by Sheldon (1988) and Williams et al. (1989). We are not aware of anyone who has explicitly addressed long-term ecosystem dynamics in the context of fish conservation. Williams et al. (1989) called for recovery efforts to restore and conserve ecosystems rather than simply habitat attributes, but they did not state how to accomplish this. Williams et al. (1989) also noted that the failure to address this concern may be a major reason no fish species has ever been recovered after listing under the U.S. Endangered Species Act (ESA; 16 U.S.C. §§ 1531 to 1544).

The purpose of this paper is to examine components of strategies necessary to provide habitat for ESUs of anadromous salmonids in the PNW. Specifically, we will consider the role of natural disturbances in creating and maintaining habitats and how an understanding of this role might be incorporated into long-term recovery planning.

Ecosystem and Spatiotemporal Considerations

May (1994) noted that the most pressing challenge to conservation biology is the need to understand the responses of organisms over large temporal and spatial scales. Some relationships between habitat condition and individual salmonid response have been well established at the scales of habitat unit (e.g., Bisson et al. 1982; Nickelson et al. 1992), stream reach (e.g., Murphy et al. 1989), and (to a lesser extent) watershed (Schlosser 1991). But there is little understanding about how biological entities such as ESUs may respond to habitat patterns at large spatial scales. An initial hurdle in recovery planning for ESUs is identifying appropriate spatial and temporal scales on which to focus.

The ESA requires that ecosystems be considered in the development of recovery plans. The ESUs of anadromous salmonids generally encompass large geographic areas (e.g., Snake River basin in Idaho, upper Sacramento River and its tributaries in northern California). It is difficult to delineate the freshwater ecosystem of an ESU over such large areas. We believe that it is reasonable to consider the composite of individual watersheds within the geographic range of an ESU to be the "ecosystem" and to direct conservation and recovery efforts for freshwater habitats toward the populations that make up an ESU. Currens et al. (in press) suggest that appropriate temporal scales for populations are several decades to centuries and that spatial scales should begin at the watershed level (Figure 1). Although temporal considerations have not been addressed explicitly, recent proposals for restoring and conserving freshwater habitats of anadromous salmonids have emphasized watersheds (e.g., Reeves and Sedell 1992; Thomas et al. 1993; Moyle and Yoshiyama 1994). We concur with this direction and believe that for management and imple-

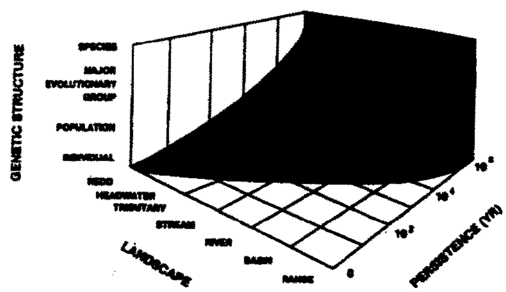

FIGURE 1.—A general hierarchial model of biological levels of organization for anadromous salmonids and the spatial and temporal scales that influence them (from Currens et al., in press).

mentation purposes, the individual watershed is the appropriate focus for recovery plans.

Within watersheds, recovery programs for ESUs must address not only root causes directly responsible for the immediate loss of habitat quantity and quality but also ecosystem processes that create and maintain habitats through time. In developing an ecosystem approach to the conservation and restoration of endangered organisms, it must be recognized that ecosystems are generally dynamic in space and time because of natural disturbances, particularly at large spaciotemporal scales (Botkin 1990).

A mosaic of conditions occurs within an ecosystem at any time as a consequence of disturbances (White and Pickett 1985). Any disturbed patch develops different habitat conditions or states over time. The assemblage of organisms in a particular patch changes with changing habitat conditions (Table 1; Huff and Raley 1991; Raphael 1991). Points along the trajectory of disturbance and recovery represent various states in the potential range of states that an ecosystem may exhibit. The locations of patches in particular states shift across the landscape due to the stochastic nature of most natural disturbances. In the PNW, terrestrial ecosystems are very dynamic in space and time as a result of natural disturbances such as fire and wind (Agee 1991, 1993). Holling (1973) noted that if resources are to be sustained, the dynamic nature of ecosystems and the need to maintain the diversity of ecosystem states must be recognized. Attempts to view and manage systems and resources in a static context may increase the rate of extinction of some organisms (Holling 1973).

Persistence in Dynamic Environments

It is unlikely that individual populations persist over long terms at the local scale in a dynamic environment (Hanski and Gilpin 1991; McCauley 1991; Mangel and Tier 1994). In dynamic environments, "... some patches are empty (but liable for colonization), while others are occupied (but liable to extinction). In such circumstances, the lights of individual patches wink on and off unpredictably, but the overall average level of illumination—the overall density of the metapopulation—may remain

TABLE 1.—Bird species found in different seral stages of Douglas-fir forests of Oregon and Washington (from Huff and Raley 1991).

Species	Seral stage		
	Early	Mid	Late
Chestnut-backed chickadee *Parus rufescens*	X	X	X
Hermit warbler *Dendroica occidentalis*	X	X	X
Western flycatcher *Empidonax difficilis*		X	X
Winter wren *Troglodytes troglodytes*		X	X
Red-breasted nuthatch *Sitta canadensis*	X		
Swainson's thrush *Catharus ustulatus*	X		
American robin *Turdus migratorius*	X		
Northern spotted owl *Strix occidentalis caurina*		X	
Pileated woodpecker *Dryocopus pileatus*		X	
Varied thrush *Ixoreus naevius*		X	

relatively steady" (May 1994). Metapopulations persist in dynamic environments through a suite of adaptations. Response to change varies with the level of biological organization (Karr and Freemark 1985; White and Pickett 1985). Physiological, morphological, and behavioral adaptations occur at the individual level. Life history patterns (Stearns 1977), reproductive rates, and modes of dispersal (Vrijenhoek 1985) are adaptations at the population level.

Several studies have documented the response of terrestrial populations to periodic catastrophic disturbances. Christensen (1985) cited examples of declines in small-mammal populations after fires in shrublands. Populations recovered after the vegetation did, and immigration from surrounding areas was a primary factor in the mammal recoveries. Colonizers of perturbed areas may be genetically predisposed to disperse (Sjorgen 1991) surplus to other populations (Hanski 1985; Pulliam 1988) or chance arrivals (Goodman 1987). Such adaptations increase the probability that metapopulations will persist through time.

The Dynamic Aquatic Environment

Aquatic ecologists and managers often do not have the long-term dynamic view of ecosystems held by terrestrial ecologists (White and Pickett 1985) and advocated by Holling (1973). Streams in the PNW (Resh et al. 1988) and elsewhere (Pringle et al. 1988; Reice 1994) are dynamic within relatively short time frames, typically a year to a decade, at the watershed scale, in response to floods or mass wasting (Swanston 1991). It is generally held that biological populations (some of them but not the entire assemblage) and physical features of these systems recover relatively quickly after such disturbances (e.g., Bisson et al. 1988; Lamberti et al. 1991; Pearson et al. 1992). Similar short-term responses of lotic fishes to disturbances have been noted in other areas (e.g., Hanson and Waters 1974; Matthews 1986). Over extended periods, habitat conditions in streams of similar size within a geomorphic region should be relatively uniform within and among watersheds (Vannote et al. 1980).

In contrast to terrestrial ecology, no theory predicts the mosaic of aquatic conditions or ecological states caused by disturbances and the corresponding responses of fish populations over extended periods. Minshall et al. (1989), Naiman et al. (1992), and Benda (1994) have proposed that aquatic ecosystems are dynamic in space and time at the watershed scale. The type, frequency, intensity and effect of disturbance vary with channel size and location within the watershed (Benda 1994).

An Oregon Example

The natural disturbance regime in the central Oregon Coast Range includes infrequent stand-resetting wildfires and frequent intense winter rainstorms. Wildfires reduce the soil-binding capacity of roots. When intense rainstorms saturate soils during periods of low root strength, concentrated landsliding into channels and debris flows may result. Such naturally occurring disturbances in stream channels can have both immediate impacts on and long-term implications for anadromous salmonids. Immediate impacts include direct mortality, habitat destruction, elimination of access to spawning and rearing sites, and temporary reduction or elimination of food resources. Longer-term effects may be positive, however; landslides and debris flows introduce essential habitat elements, such as large wood and sediment, into channels and affect storage of these materials. The configuration of channel networks, the delivery, storage, and transport of sediment and wood, and the decomposition of woody debris interact to create, maintain, and distribute fish habitat over the long term.

Three streams in the central Oregon Coast Range were examined to explore some of the responses of salmonids and their habitats to the natural disturbance regime (G. H. Reeves, U.S. Forest Service, Pacific Northwest Research Station, unpublished data). The streams have gradients between 1 and 2.5% and drainage areas between 14 and 18 km^2. Benda (1994) examined these and other streams as part of a study to model watershed erosion and sedimentation. Summer habitats and assemblages of juvenile anadromous salmonids were inventoried in 1988 and 1989. The time since catastrophic wildfire and hillslope failure differed among streams.

The watershed of Harvey Creek was burned by an intense wildfire in the late 1800s, and the forest was principally 90–100-year-old Douglas fir *Pseudotsuga menziesii* at the time of the study. The channel contained a large volume of sediment in storage throughout the lower portion of the drainage network and thus was considered to be in an aggradational state (mean depth of deposits, 1.8 m). Evidence of burned wood in the channel indicated widespread landsliding followed the fire. Gravel was the dominant substrate (Figure 2). Larger substrate particles and large woody debris were buried in the gravel deposits. Deep pools (mean depth, 0.9 m),

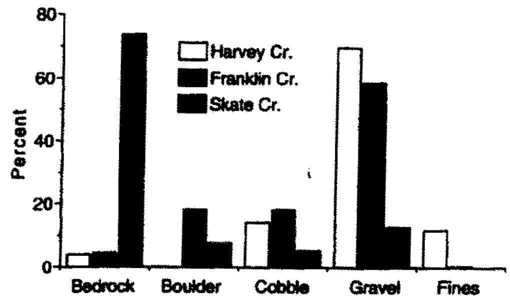

FIGURE 2.—Substrate composition in three streams of the central Oregon Coast Range that had differing histories of major natural disturbance. The time since the last major natural disturbance was 90–100 years for Harvey Creek, 160–180 years for Franklin Creek, and more than 330 years for Skate Creek. Cr = Creek (G. H. Reeves, unpublished data collected in July 1988 and 1989).

usually formed by scour around large wood, were the most common habitat units but were not hydraulically complex. Fewer pieces of large wood were observed in Harvey Creek than in the other study streams (Table 2), because wood deposited in the channel by the hillslope failure had been buried beneath sediment and little wood was being recruited from the relatively young surrounding forest. The juvenile salmonid assemblage was numerically dominated by age-0 coho salmon *Oncorhynchus kisutch*, but age-1 steelhead *O. mykiss* (about 1%) and cutthroat trout *O. clarki* (about 1%) were also present (Table 3).

The Skate Creek watershed was forested by trees more than 330 years of age, suggesting that the stream had not been subjected to a fire or hillslope failure for a long time. Habitat conditions in the stream were very simple. The substrate was predominantly bedrock and boulders with small, localized patches of stored sediment (Figure 2). Riffles were thin sheets of water flowing over bedrock. Although large wood was more abundant than in the other streams examined (Table 2), the lack of a deformable gravel bed greatly limited the wood's effectiveness in forming pools. Therefore, pools were shallow (mean depth, 0.1 m) and often in bedrock depressions. Juvenile coho salmon were the only salmonids found in Skate Creek (Table 3).

Franklin Creek was intermediate in time since disturbance. Based on the present vegetation, we estimated that catastrophic wildfire and landsliding occurred 160–180 years ago in this watershed. Mean depth of sediment in the channel was 0.7 m, and there was a greater array and more even distribution of substrate types than in the other streams (Figure 2). Mean pool depth was 0.35 m, less than half the mean depth of pools in Harvey Creek. As a result of sediment transport from the channel that

TABLE 2.—Mean number of pieces of large wood (>0.3 m in mean diameter and >3 m long) per 100 m in three streams of the central Oregon Coast Range that had differing histories of major natural disturbance (G. H. Reeves, unpublished data collected in July 1988 and 1989).

Stream	Years since last major disturbance	Mean pieces of wood/100 m
Harvey Creek	90–100	7.9
Franklin Creek	160–180	12.3
Skate Creek	>330	23.5

TABLE 3.—Composition of the assemblage of juvenile anadromous salmonids in three streams of the central Oregon Coast Range that had differing histories of major natural disturbance (G. H. Reeves, unpublished data collected in July 1988 and 1989).

	Mean percent of estimated total numbers		
Stream	Age-0 coho salmon	Age-1 steelhead	Age-1 cutthroat trout
Harvey Creek	98.0	1.0	1.0
Franklin Creek	85.0	12.5	2.3
Skate Creek	100.0	0.0	0.0

partially excavated buried wood and of recruitment of wood from the surrounding riparian forest, Franklin Creek had more pieces of large wood than Harvey Creek, though fewer than Skate Creek (Table 2). The combination of these factors produced the most complex habitat conditions observed in the three streams. Coho salmon numerically dominated the juvenile salmonid assemblage, but steelhead and cutthroat trout were relatively more abundant than in Harvey Creek (Table 3). Botkin et al. (1995) found that the healthiest stocks of various anadromous salmonids in coastal Oregon and northern California occurred where riparian vegetation within 0.5 km of the stream was similar to that found along Franklin Creek.

These field observations and a simulation model developed by Benda (1994) indicate that under the natural disturbance regime, variation in the timing and location of erosion-triggering fires and storms results in episodic delivery of materials that cause stream channels to alternate between aggraded and degraded sediment states. This generates spatial and temporal variability in both habitat conditions (Figure 3) and components of the juvenile salmonid assemblage within and among watersheds. Benda's (1994) simulation model indicated that wildfires of a mean size of about 30 km^2 occurred in the central Oregon Coast Range over the past 3,000 years with a return interval of 200–300 years. The cumulative probability of wildfire increased with increasing watershed size; for a 200-km^2 drainage basin, the frequency of stand-resetting wildfires was once every 45 years.

At a coarse level of resolution, Benda's (1994) model predicted that channels in watersheds of similar drainage area have characteristic patterns of sediment delivery, storage, and transport that vary with position in the drainage network and drainage area. Under a natural fire regime, for example, streams in the upper drainage experience large sediment deposits (>1 m thick) infrequently (once every hundreds of years) because sources of mass failure are few and sediment bedload transport rates are low. Channels in the central part of the network (drainage area, 30–50 km^2) have the highest probability of containing thick sediment deposits, partly due to relatively high cumulative probabilities of upstream mass wasting. These channels experience cycles of accumulation and flushing as sediment is transported in waves into and then out of them. Channels higher than sixth order with large drainage areas (>100 km^2), are governed by lateral migrations rather than by cycles of filling and emptying. Sediment waves moving from tributaries into

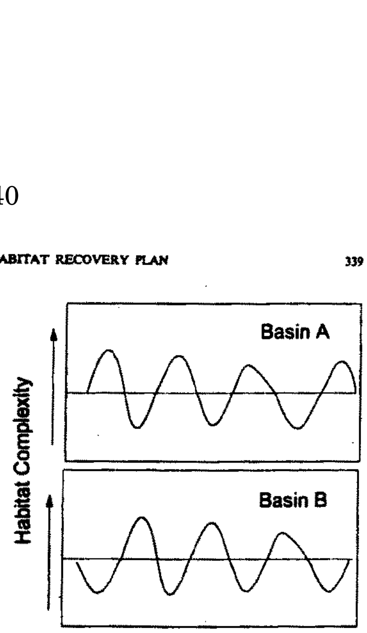

FIGURE 3.—Hypothetical historical conditions of fish habitat in different streams within and among watersheds in the central Oregon Coast Range (based on Benda 1994). The horizontal axis is time.

larger channels mix at tributary junctions. Although sediment waves occur once in 5–10 years, they probably are inconspicuous (depth, < 0.2m). Habitat conditions in unbraided channels in the lowest portion of the network likely are more uniform than in higher elevation channels. It is important to note that the occurrence of a particular state will be affected by local circumstances that influence sediment retention, such as the amount of large wood in the channel, but these were not modeled by Benda (1994).

In the model, stream channels draining watersheds similar in area to Harvey, Franklin, and Skate creeks oscillated over time between states of sediment aggradation and degradation (Benda 1994). For central Oregon Coast Range channels, the average period between the state characterized by sediment deposits of intermediate depth, as exhibited in Franklin Creek, and the sediment-poor state was estimated to be more than 100 years. The model also produced an average duration of gravel-rich conditions of 80 years (range, 50–300 years) in small basins. Harvey Creek has apparently been gravel-rich for 100 years, and may continue to be so for another 100 years, although gravel-rich areas will likely move downstream over time. Again, the duration of a particular condition would be affected by local circumstances that were not modeled by Benda (1994).

Juvenile salmonid assemblages are likely associated with each state predicted by the model. Benda's (1994) simulation indicated that sediment supply would be limited at any given location in these small streams a majority of the time. Based on field observations, coho salmon would have dominated such simplified habitats. When a channel segment was not in this degraded state, it would shift between states of aggradation and intermediate sediment supply. Two additional salmonid species, steelhead and cutthroat trout, are expected to occur in aggraded channels. The intermediate state is characterized by intermediate sediment depths and more complex habitat, which should support a juvenile salmonid assemblage containing greater proportions of trout. Benda (1994) has developed long-term average probabilities for the time a channel segment would have spent in each state. Applied to a population of channels (those with similar gradient, drainage area, etc.) for a particular time, these probabilities can be used to estimate the landscape-scale mosaic of habitat conditions or biodiversity. For example, in watersheds of an area similar to those in the field example (approximately 25 km^2), the frequency distribution developed by Benda (1994) indicates that a majority of channel segments in the central Oregon Coast Range should have limited sediment supplies at any particular time and thus should contain relatively simple habitats.

A natural mosaic of habitat conditions for anadromous salmonids has likely existed elsewhere in the PNW; the features and relative proportion of each channel state should vary with climate, vegetation, drainage pattern, and spatial scale. Meyer et al. (1992) found cycles of aggradation and degradation associated with wildfires and hillslope failures in a Wyoming stream like those just described for the central Oregon Coast Range. It seems reasonable to assume that channel conditions over time were similar to those observed in the Oregon streams we examined.

In summary, the natural disturbance regime of the central Oregon Coast Range is described by the frequency, size, and spatial distribution of wildfires and landslides, and this regime has been responsible for developing a range of channel conditions within and among watersheds. The structure and composition of the juvenile anadromous salmonid assemblage varies with channel conditions. A disturbance regime that resembles this natural regime must be incorporated into any recovery plan for freshwater habitats of ESUs of anadromous salmonids.

Adaptations of Anadromous Salmonids

Anadromous salmonid populations in the Pacific Northwest are well adapted to dynamic environments. Adaptations include straying by adults, high fecundity, and mobility of juveniles. Straying by adults is genetically controlled, directly or indirectly (Quinn 1984), and aids the reestablishment of populations in disturbed areas on large (Neave 1958) and local scales (Ricker 1989). Strays would be reproductively most successful where local populations have been reduced or extirpated (Tallman and Healey 1994), provided there are suitable spawning and rearing conditions. Individuals from more than one population may recolonize depopulated areas, increasing the genetic diversity of the new population.

Movements of juveniles from natal streams to other areas also facilitate the establishment of new populations. Some individuals may be genetically programmed to move; others may be displaced from high-density populations (Northcote 1992). Chapman (1962) suggested that juvenile salmonids that were unable to obtain territories and migrated downstream were less fit individuals. However, at least some may leave voluntarily if emigration improves survival. Tschaplinski and Hartman (1983) found that juvenile coho salmon moving downstream in a small British Columbia stream took up residence in unoccupied habitats and grew rapidly.

High fecundity contributes to the establishment and growth of a local population if conditions are favorable. Pacific salmon are relatively fecund for benthic-spawning fishes with large eggs. Pink salmon *Oncorhynchus gorbuscha*, the smallest species, typically possess 1,200–1,900 eggs per female (Heard 1991). Adult female chinook salmon *O. tshawytscha*, the largest species, may contain more than 17,000 eggs (Healey 1991). Both high fecundity and large eggs contribute to the reproductive success of species whose young have extended periods of intragravel residence. These traits also facilitate growth when conditions are suitable.

Human Alterations of Disturbance Regimes

Natural ecosystems generally have a large capacity to absorb change without being dramatically altered. Resilience of an ecosystem is the degree to which the system can be disturbed and still return to a domain of behavior in which processes and interactions function as before (Holling 1973). If a disturbance exceeds the resilience of the system, the domain may shift and the system will develop new conditions or states that had not previously been exhibited. Yount and Niemi (1990), modifying the disturbance definition of Bender et al. (1984), distinguished "pulse" disturbances from "press" disturbances. A pulse disturbance allows an ecosystem to remain within its normal bounds or domain and to recover the conditions that were present prior to disturbance. A press disturbance forces an ecosystem to a different domain or set of conditions. Yount and Niemi (1991) considered many anthropogenic disruptions, such as timber harvesting and urbanization, to be press disturbances. Gurtz and Wallace (1984) hypothesized that stream biota may not be able to recover from the effects of anthropogenic disturbances because these have no analogues in the natural disturbance regime, and organisms may not have evolved the appropriate breadth of habitat or reproductive requirements.

Modifications in the type of disturbance or in the frequency and magnitude of natural disturbances can alter the species composition, habitat features, and resilience of an ecosystem (White and Pickett 1985; Hobbs and Huenneke 1992). Alteration or loss of habitats as a result of changes in the disturbance regime can bring on extirpation of some species, increases in species favored by available habitats, and invasions of exotic organisms (Levin 1974; Harrison and Quinn 1989; Hansen and Urban 1992). We also believe that changes in the legacy of disturbance (the conditions that exist immediately following a disturbance) may be another important component of disturbance regimes that can be altered. Changes in the legacy can influence a system's resiliency by altering habitat conditions created immediately following a disturbance and by altering future conditions.

We do not mean to imply that every human action or activity causes a press disturbance; the impact of anthropogenic disruptions is minimal in some ecosystems (e.g., Attiwill 1994a, 1994b). However, we believe human activities that affect anadromous salmonids and their habitats, such as timber harvesting, urbanization, and agriculture, do generate press disturbances. These disturbances can result in the loss of habitats or ecosystem states necessary for various anadromous salmonids (Hicks et al. 1991; Bisson et al. 1992). Human activities in the PNW have altered the recovery potential of ecosystems, which may be as responsible for the decline of habitat as the direct impact of the activity itself.

A Disturbance-Based Ecosystem Approach to Freshwater Habitat Recovery

We believe that any long-term program for restoring and maintaining freshwater habitats for ESUs of anadromous salmonids must accommodate the dynamic nature of the PNW landscape. Given the dynamic nature of terrestrial ecosystems (Agee 1991, 1993), the links between terrestrial processes and aquatic ecosystems, the apparent adaptations of anadromous fish for persisting in a dynamic environment, and the limited available evidence (based on central Oregon Coast Range streams) of non-steady-state behavior of sedimentation and habitats, we believe a dynamic approach is advisable in any recovery program. In the following sections, we describe the components that should be included in this approach.

Watershed Scale Reserves: Short- and Long-term Considerations

Anadromous salmonids exhibit typical features of "patchy populations"; they exist in a dynamic environment and have good dispersal abilities (Harrison 1991, 1994). Conservation of patchy populations requires the conservation of numerous patches of suitable habitat and the potential for dispersal among them (Harrison 1991, 1994). Size and spacing of reserves should depend on the behavior and dispersal characteristics of the species of concern (Simberloff 1988). Rieman and McIntyre (1995) used logistic regression to investigate the influence of patch size as well as stream width and gradient, on populations of bull trout *Salvelinus confluentus* at the reach, stream, and watershed scales. This approach could be helpful in identifying critical features of reserves for anadromous salmonids. In our current thinking on reserve planning for ESUs of anadromous salmonids, we consider patches to be watersheds, the size of which should depend on the species and geographic location. It is difficult to predict the exact number of patches required to sustain an organism (Lawton et al. 1994). Lande (1988) could do this for the northern spotted owl because data were available on essential life history variables. It is unlikely that predictions could be obtained for many other species, including ESUs of anadromous salmonids, because necessary life history data are often lacking (Lawton et al. 1994).

In the short term, reserves should be established in watersheds with good habitat conditions and functionally intact ecosystems to provide protection for these remaining areas. Reserves of this type are likely to be found in wildernesses and roadless areas on federal lands. Examples of watersheds that fulfill this requirement include some of the key watersheds identified by Reeves and Sedell (1992), the class I waters of Moyle and Yoshiyama (1994), and

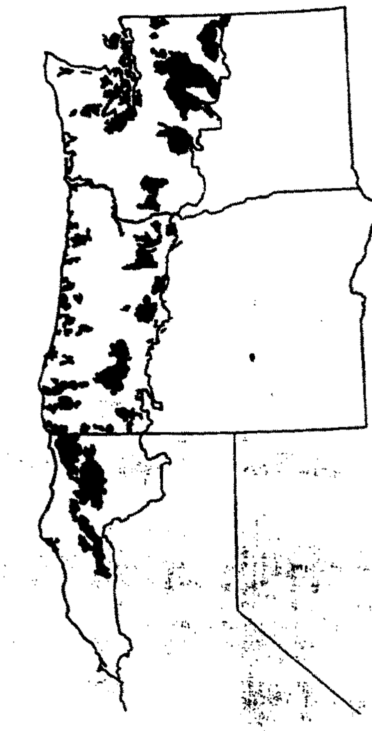

FIGURE 4.—Distribution of tier 1 key watersheds identified by Thomas et al. (1993).

the tier 1 key watersheds of Thomas et al. (1993) (Figure 4). Ideally these reserves should be distributed across the range of an ESU and should contain subpopulations of it. Because of the critical importance of these watersheds in the short term, activities within them should be minimized or modified to protect the integrity of existing physical and ecological conditions.

Identification of watersheds that have the best potential for being restored should also be a short-term priority of any recovery strategy. These watersheds could serve as the next generation of reserves. Systems should qualify based on the extent of habitat degradation and the degree to which their natural diversity and ecological processes are retained. Examples of such watersheds are some of the key watersheds identified by Reeves and Sedell (1992), some tier 1 key watersheds identified by Thomas et al. (1993), the class III waters of Moyle and Sato (1991), and the class III waters of Moyle and Yoshiyama's (1994) aquatic diversity management areas. Restoration programs implemented in these watersheds should be holistic in their approach. They should address instream habitat concerns, prevent further degradation, and restore ecological processes that create and maintain instream habitats.

It is imperative to recognize and acknowledge that identified reserves will experience natural and, often, anthropogenic disturbances. Thus, simply putting aside a fixed set of watersheds as reserves may not provide habitats of sufficient quantity and quality to ensure long-term persistence of ESUs. Conservation reserves have generally been established and managed without consideration of long-term disturbance dynamics and the biological and evolutionary processes that influence organisms contained within them (Western 1989). Consequently, their populations may have higher probabilities of extirpation in the long term than expected. Reasons for this include isolation of reserves from surrounding areas of suitable habitat resulting from habitat fragmentation (MacArthur and Wilson 1967; Diamond and May 1976); restriction or elimination of migration and dispersal (Eisenberg and Harris 1989; Harris and Eisenberg 1989); and boundary effects associated with surrounding areas, such as invasion of native and exotic competitors, disease, and pollution (Shonewald-Cox 1983; Wilcox 1990). Hales (1989) and White and Bratton (1980) noted that in dynamic landscapes, reserves may act as holding islands that persist only for relatively short ecological periods (100–200 years). Reserves should be large enough to allow operation of the natural disturbance regime and to support a mosaic of patches with different biological and physical attributes (Pickett and Thompson 1978).

Gotelli (1991) noted that reserve strategies such as those proposed by Harrison (1991, 1994) do not address the longevity of patches. This is a major concern in dynamic environments like those of the PNW. Modification of the strategy proposed by Harrison (1991, 1994) to accommodate a dynamic environment is a prudent approach in the development of a recovery strategy for anadromous salmo-

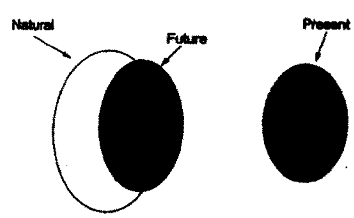

FIGURE 5.—Conceptual representation of the range of conditions experienced by aquatic ecosystems historically, currently, and under a new disturbance regime (modified from H. Regier, University of Toronto, personal communication).

nid habitats. Specifically, there is need for a shifting mosaic of reserves that change location in response to the ability of specific watersheds to provide suitable habitat conditions.

A New Human-Influenced Disturbance Regime

Under natural wildfire regimes of the PNW, the condition of freshwater habitats for anadromous salmonids was likely regulated by episodic delivery of sediment and wood to the channel. Given that human demands on ecosystems will only increase, we believe that returning the entire landscape to the natural wildfire regime will not be possible. Therefore, human activities will have to be molded into an analogous disturbance regime if habitats are to recover and persist. First must come an understanding of how the natural disturbance regime created and maintained habitats for anadromous salmonids through time and how it has been modified by human activity. Then it will be necessary to identify those human activities that can be altered to maintain desired ecological processes and leave the legacy that allows recovery and persistence of required freshwater habitats. In other words, the character of anthropogenic disruption must be shifted from a press to a pulse disturbance (Yount and Niemi 1990) (Figure 5). The following is an example of how we believe timber harvest and associated activities, as currently practiced on federal lands in the central Oregon Coast Range, have affected habitat and biodiversity of anadromous salmonids and how these could be adjusted to help create suitable conditions in space and time. We believe that timber management may offer more immediate opportunities than agricultural or urban processes for modifying practices to create a human-influenced disturbance regime that maintains components of the natural regime.

Disturbance caused by timber harvest differs from stand-resetting wildfires in the central Oregon Coast Range in several respects. One difference is the legacy of the disturbance. Wildfires left large amounts of standing and downed wood (Agee 1991), which was often delivered to channels along with sediment in storm-generated landslides (Benda 1994). This promoted development of high-quality habitats as sediment was transported from the system, leaving the wood behind (Benda 1994). Timber harvest, as it is generally practiced, reduces the amount of large wood available to streams (Hicks et al. 1991; Reeves et al. 1993; Ralph et al. 1994), so when harvest-related hillslope failures occur, sediment is the primary material delivered to the channel (Hicks et al. 1991). Because large wood is an integral component of aquatic habitats and a major influence on sediment transport and storage, the potential for developing complex habitats is much lower when small rather than large amounts of wood are in the channel. Consequently, channels may be simpler following timber harvest than they are after wildfires.

The interval between events also affects the conditions that develop after a disturbance (Hobbs and Huenneke 1992). Under the natural disturbance regime, variation in the timing and location of erosion-triggering fires and storms probably caused stream channels to alternate between aggraded and degraded sediment states, generating temporal variability in both fish habitats and assemblages of juvenile salmonids. Wildfires occurred on average about once every 300 years in the central Oregon Coast Range (Benda 1994). In watersheds smaller than 30 km^2, postfire development of the most diverse physical and biological stream conditions may have taken 150 years or more (see earlier discussion). Timber harvest generally occurs at intervals of 60–80 years on public lands and 40–50 years on private timberlands. This may not allow sufficient time for the development of conditions necessary to support the array of fishes found under natural disturbance regimes.

A third difference between timber harvest and a disturbance regime dominated by wildfire is the spatial distribution of each. Based on a fire frequency of once every 300 years, Benda (1994) estimated that on average, 15–25% of the forest in the central Oregon Coast Range would have been in early successional stages because of recent wildfires. In contrast, the area affected by timber harvest is much greater. For example, in the Mapleton District of the Siuslaw National Forest, which contains the watersheds studied by Benda (1994), approximately 35% of the forest is in early succession (J. Martin, Siuslaw National Forest, personal communication). If private lands were included, the percentage would be greater. The present forested landscape is more homogeneous with respect to seral stage than it was historically. Just as the distribution of terrestrial habitat has been altered by switching from a wildfire-driven to a harvest-driven disturbance regime, it is also possible that the distribution of aquatic habitats is different today than it was under the natural disturbance regime and thus less capable of supporting a diverse juvenile salmonid assemblage.

A fourth difference between the natural wildfire-driven and the current harvest-driven regime is the size of disturbance and the landscape pattern generated by the disturbance. Timber on federal lands has typically been managed by widely dispersed activities; approximately 174,000 km of roads exist across public lands in the range of the northern spotted owl (Thomas et al. 1993), and many millions of hectares have been affected by small harvests of approximately 16 ha. Wildfires, on the other hand, often generate a larger but more concentrated disturbance. When wildfires occurred in the central Oregon Coast Range, they tended to be large (mean, 3,000 ha), stand-resetting fires (Benda 1994). Consequently, the spatial pattern and amount of sediment delivered to channels would likely be different under these two disturbance regimes. In naturally burned areas, storms occurring during periods of low root strength would generate large volumes of sediment from nearly synchronous hillslope failures and channels would become aggraded. Subsequently, delivery would be reduced while source areas recharged. This, coupled with downstream flushing of stored sediments, would bring the channel to an intermediate level of sediment storage and a corresponding period of high-quality habitat. In unburned watersheds, sediment delivery rates would remain low. In contrast, timber harvest activities are dispersed; thus, we presume that mass wasting would be more widely distributed and would deliver sediment at elevated rates in most managed watersheds. Storm-generated landslides would be asynchronous, being governed through time by harvest schedules. Cycles of channel aggradation and degradation probably would not be apparent and sediment delivery, at a landscape scale, would likely be chronic rather than episodic. These factors would conspire to produce relatively low-quality habitats across the landscape and eliminate the potential for attaining the most complex habitat states.

In summary, the differences between present timber harvest disturbance regime and the natural disturbance regime have important implications for stream ecosystems and anadromous salmonids. Stream habitat, at a point in the channel, is less complex under the timber harvest regime (Hicks et al. 1991; Bisson et al. 1992) than under the natural regime, and the potential for achieving greater complexity is also reduced. This is primarily a result of the reduced legacy and shorter interval between disturbance events under the timber harvest regime. In addition, landscape-level habitat heterogeneity is reduced under the harvest regime because the disturbance is more dispersed and widespread.

The new disturbance regime created by timber harvest should address the concerns just listed. The legacy of hillslope failures associated with timber management activities needs to include more large wood. Benda (1990) identified the attributes of first- and second-order streams that favor the delivery of desirable material to fish-bearing channels. Increasing the extent of riparian protection along these streams, as proposed by Thomas et al. (1993), obviously increases the potential delivery of wood. Such a strategy may not result in wood loadings as large as occurred naturally because trees away from the riparian zone will have been removed. However, this strategy should increase wood loadings beyond what is currently possible and should allow channels to develop more complex habitats.

Longer intervals between harvest rotations could be another component of this new disturbance regime. In single basins in the central Oregon Coast Range, the desirable interval may be 150–200 years, although this is a first approximation. The exact interval would depend on the magnitude and areal extent of the natural disturbance regime and the time it takes for favorable habitat conditions to develop if adequate large wood and sediment are available. It will be different in other regions. Extending rotation time would also provide benefits to many terrestrial organisms.

Concentrating rather than dispersing management activities could be another element of the new disturbance regime. This would more closely resemble the pattern generated by natural disturbances than does the current practice of dispersing activity in small areas. For example, if a basin has four subwatersheds, it may be better to concentrate activities in one for an extended period (50–75 years) than to operate in 25% of each one at any time

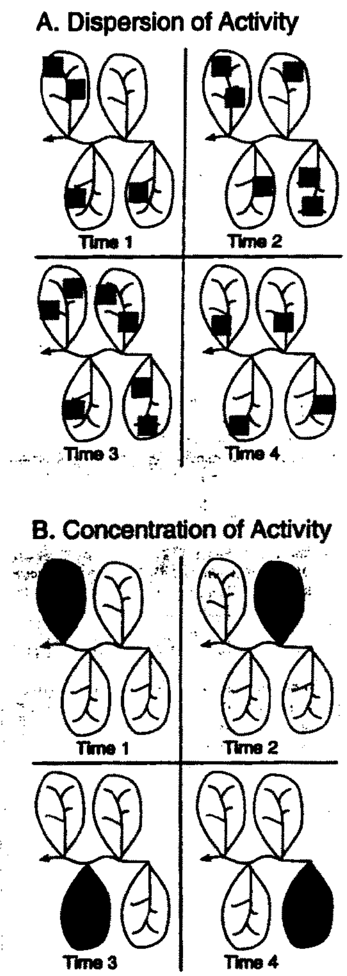

FIGURE 6.—Examples of patterns resulting from (A) dispersing and (B) concentrating land management activities in a watershed over time (modified from Grant 1990).

(Figure 6). Grant (1990) modeled such a scenario to determine its effects on patterns of peak flow and found that there was little difference between the two approaches. Franklin and Forman (1987) believed that dispersing activity (Figure 6A) increases habitat and landscape fragmentation and is more detrimental than concentrating activities (Figure 6B) to terrestrial organisms that require late-successional forests. We believe that concentrating activity would have similar benefits for the aquatic biota if the elements discussed previously are included. This approach could also be linked to planning future reserves and reducing risks in reserves, so it merits consideration in the development of habitat recovery efforts.

All of the elements discussed above must be included in the development of a new disturbance regime if the regime is to be successful at creating and maintaining habitats for anadromous salmonids. Exclusion of any element greatly reduces the potential for success. Our concept of designing a disturbance regime around human activities could complement parts of other strategies proposed for management of the central Oregon Coast Range (Noss 1993) and other parts of the PNW (e.g., Thomas et al. 1993). These call for reserves in which human activity is curtailed or eliminated. The proposed new disturbance regime could be applied to areas outside any such reserve system, particularly in the short term. It could also guide management strategies in reserves where limited human activity is allowed. The long-term goal of this effort would be to create refugia to replace and complement refugia in permanently designated reserves, such as wilderness areas and other withdrawn lands.

Conclusions

Plans directed at the freshwater habitat for ESUs of anadromous salmonids in the Pacific Northwest must be focused on restoring and maintaining ecosystem processes that create and maintain habitats through time. It is important to insure that as good habitats "wink out," either through anthropogenic or natural disturbances or through development into new ecological states, others "wink on." Designating the most intact remaining aquatic ecosystems as reserves is essential for meeting near-term requirements. In the long term, a static reserve system alone is unlikely to meet the requirements of these fish. Management must also be directed at developing the next generation of reserves. Strategies should be designed and implemented that treat land management activities as disturbance events to be manipulated so as to retain the ecological processes necessary to create and maintain freshwater habitat through time. Although necessary for anadromous salmonids, the approach of moving reserves and managing periodic disturbances may not be suitable for locally endemic or immobile biota. It is imperative to consider the needs of other organisms in the development of any habitat recovery program for ESUs of anadromous salmonids.

Many hurdles must be overcome to make our approach effective. First, biologists, managers, and planners need to think in longer time frames than they are generally accustomed to using. They need to acknowledge that ecosystems are dynamic in space and time over these longer periods. Simply designating reserves and expecting these to function as such for extended periods may be unrealistic; some benefits may accrue in the short term, but in the long run it is unlikely that habitats of sufficient quality and quantity will be available to sustain ESUs of anadromous salmonids. Expectations about habitat conditions in streams must change; a stream will not always have suitable habitats for anadromous salmonids, and all streams should not be expected to have suitable habitats at the same time. A consequence of a dynamic view is that, perspectives must be regional (Holling 1973). The percentage of the landscape that should contain suitable habitats must be identified and the temporal and spatial distributions of these habitats determined.

Finally, disturbance must be recognized as an integral component of any long-term strategy. This will be a difficult hurdle to overcome. It requires educating resource managers, scientists, administrators, politicians, and the public so they realize that periodic disturbance is not necessarily negative. To the contrary, disturbance may be necessary in order to have productive habitats for ESUs of anadromous salmonids in the PNW over long periods.

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Disturbances

And

The Douglas Fir Region

TABLE OF CONTENTS

INTRODUCTION

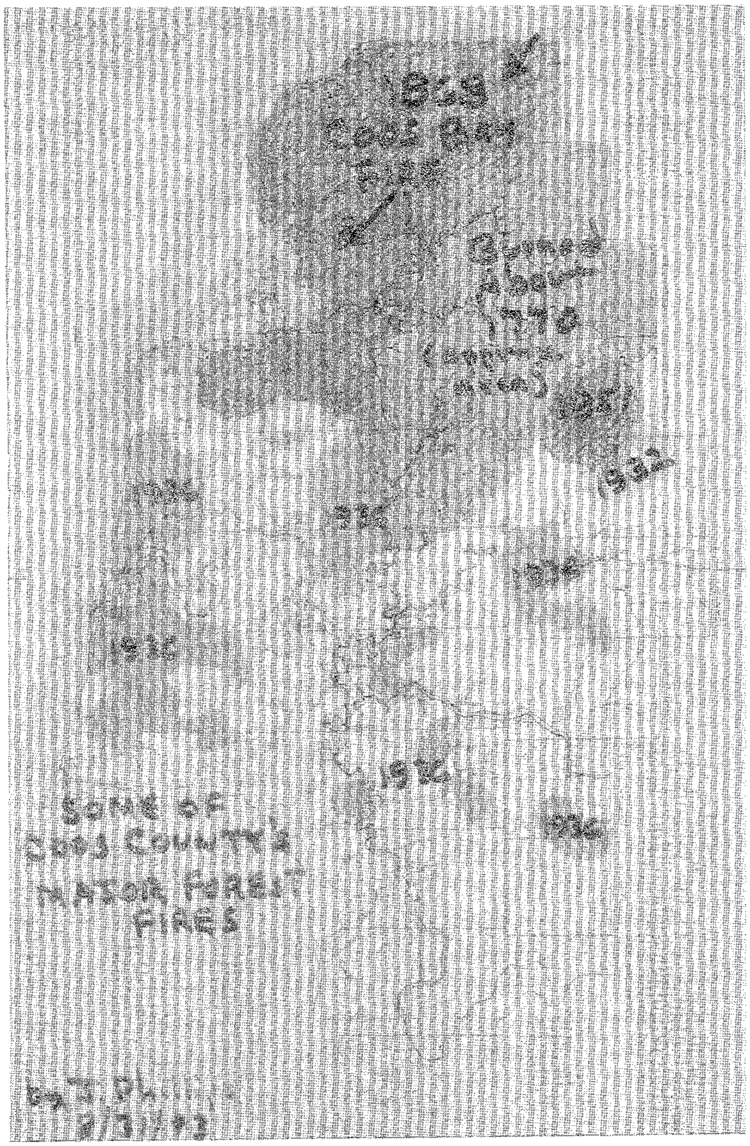
Unlike the ecology of the pine forests in so much of America, whose matrix was shaped by frequent low intensity fire, the Douglas Fir region of the Pacific Northwest was shaped by infrequent, catastrophic events. These stand-replacing events that killed most everything on areas sometimes as large as several hundred thousand acres account for the predominance of Douglas Fir rather than shade tolerant species in the region west of the Cascade Range in Washington, Oregon and Northern California.

And, contrary to the common belief that the best anadromous streams are to be found in the undisturbed Old Growth forests, it is the disturbances of fire and flood that have given these streams their spawning gravel and large woody debris, creating the complexity needed for the fresh water portion of the salmoniods life cycle.

It will require **ACTIVE MANAGEMENT**, not "no touch buffers" to replicate those events that gave us fir trees and salmon.

PART 1

FIRE


Big
Coos Bay
Fire
Burned
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SOME OF
COOS COUNTY'S
MAJOR FOREST
FIRES

August 30, 1993

Mr. Gordon Ross
Coos County Board of Commissioners
Courthouse
Coquille, Oregon 97423

Dear Commissioner Ross,

Herewith is a map of Coos County on which I have color-coded the major forest fires of the past - to best of my knowledge and ability. This subject has been of interest to me during my entire career in Forestry in Coos County, and I have tried to build this knowledge over these many years.

I am a professional Forester, with a Bachelor of Science Degree in Forest Management from Oregon State University. My career spanned some 38 years, 37 of which were in Coos County, with the Oregon State Board of Forestry. During the 19 years prior to my retirement I was the District Forester for the Coos District, including being the Manager of the Elliott State Forest. Forest fire prevention and control is one of the main missions of that organization.

My reason for writing is that I have a deep concern about the future viability of the forest resources of Coos County from the standpoint of fire protection. This stems from the current political moves to severely curtail forest harvesting on public ownerships. And my guess is that almost 300,000 of the 800,000 acres of forestland in Coos County are publicly owned.

My concern is over progressive "fuel build-up," resulting from decreased harvesting of over-mature timber. Fire professionals speak of the "fire triangle," which, of course, consists of air, heat, and fuel. We cannot, in a forest potential fire situation, control the air, or the heat (lightning, for example), but we can "manage" the fuel loading, largely through harvest of older, highly inflammable Douglas-fir timber.

All of Western Oregon's major historic forest fires have occurred in those overmature Douglas-fir timber stands. And, in spite of all modern fire suppression techniques and money spent, they may continue if the fuel loading is not managed (witness the 1987 Silver Fire on the nearby Siskiyou National Forest, covering some 100,000 acres of older timber stands.)

A final point: the Oregon State Dep't of Forestry has one of the Nation's most effective fire suppression organizations. It is based on immediate response with heavy equipment and skilled personnel - much of which must come from logging cooperators. Greatly reduced harvesting also greatly reduces fire control ability in all of Western Oregon - including Coos County.

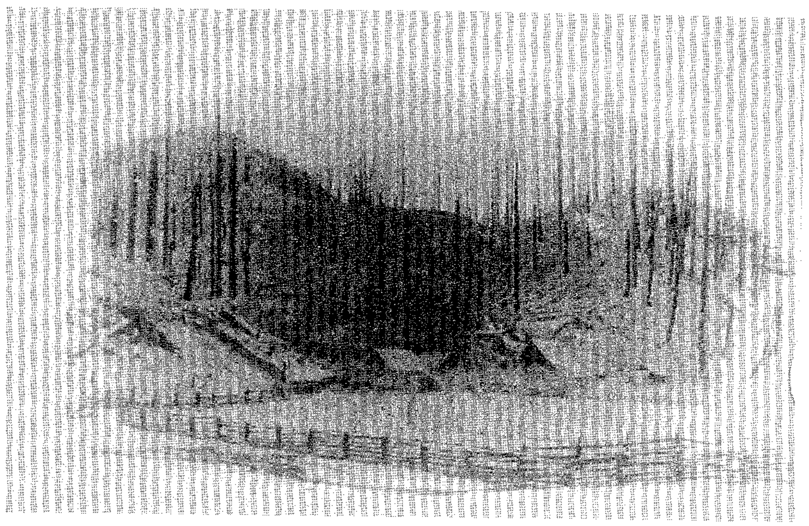
I pray that Coos County's forests will not be jeopardized by poorly thought-out political actions.

Jerry Phillips

A Forty Acre Sight on the North Fork of the Coquille River
Near Rock Prairie That Has Been Undisturbed by Fire For 350 Years

The Fir trees that remain standing are all approximately 350 years old. Many have fallen and hard woods have come up to fill in the space. For a period of 350 years no new fir trees have come up through the under story. If no disturbance opens up this area (e.i. fire or logging) the future of this sight will be a hard wood forest.

If we could be successful in setting aside all Federal timber land from harvest, and if we could protect it from fire, we would be producing a forest for the most part very different from what nature produced.

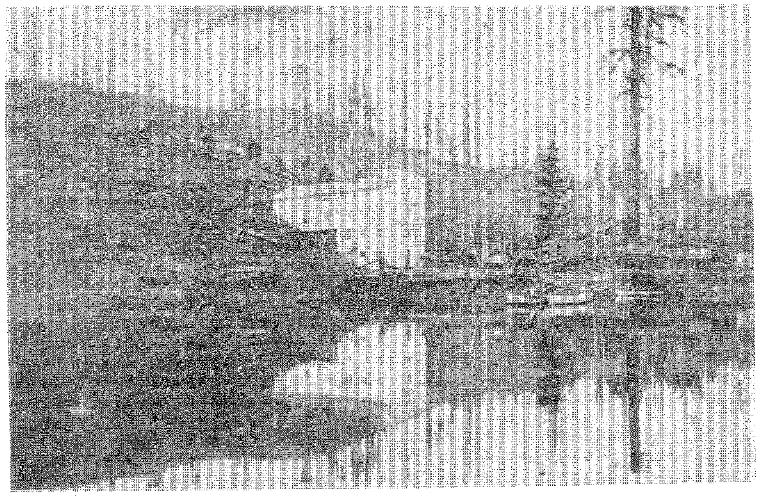


Fire of 1868 at the sight of the Elkhorn Ranch,
now within the Elliot State Forest.

This 300,000 acre blaze that forced settlers from their homes and destroyed wildlife was typical of the scope of many of the catastrophic fires of the past referred to in the BLM fire maps.

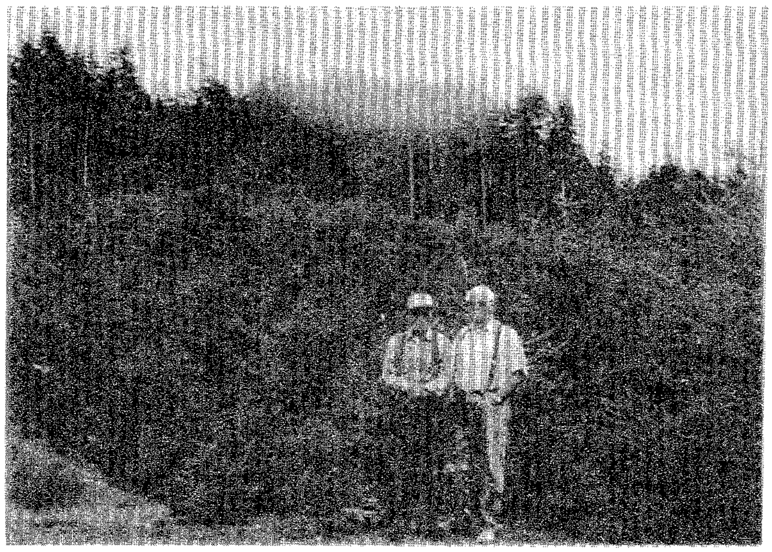
Here, as in many other places after catastrophic fire, reburns as late as 20 to 30 years after the original burn were extensive because of the large amount of fuel loading left by the first fire and the punky sap wood breaking off, as pitchy snags explode, acting as fire brands driven ahead by the wind of the fire and igniting ahead, hastening the speed of the fire or sometimes creating its own back fire.

The buildings in this picture were built after the original fire.



My forbearers protected their homes against the fire of 1868 which jumped the South fork of the Coos River at this point. This fruit drying facility was built by my mother's grandfather in 1876, eight years after the fire. When my grandfather moved over the hill to Stock Slough in 1882 he said there wasn't a tree on the hills taller than his shoulder. In 1946 he sold merchantable timber measuring as much as 40" on the stump.

In 1874 two reporters from Coos Bay walked to Sumner, a distance of 11 miles, to review the work on the Coos Bay Wagon Road. They reported not seeing a live tree.



Two Even Aged Stands of Douglas Fir.

God planted the stand in the background and man planted the stand in the foreground. That in the rear grew after the fire of 1868; that in the foreground was planted after a clear-cut in 1982. Both stands are 90% Douglas Fir.

In the immediate foreground, the second growth appears to have outgrown the old growth.

Even Aged Stand of Fir Coming Back After Fire of 1868.

Even aged stands of Douglas fir denote and date the time of catastrophic fires. From place to place some trees survived and if these were of similar age it helps date the former fire. Local Coos Bay loggers referred to the reprod after the 1868 fire as 3rd growth timber because the forest that was destroyed was of two age classes referred to a 1st and 2nd growth, the latter being that which probably survived the "Skookum Fire".

Again, Douglas fir stands are principally the result of fire and the monoculture produced by them was as typical after fire as after clear cuts. In 1930 a cruise by the County of all its taxable timber shows the percentages to be of each type

Old Growth Fir	46.6%
Second growth Fir	44.7%
Port Orford Cedar	2.6%
Spruce	2.9%
Hemlock	2.1%
Red Cedar	.5%
White Fir	.36%

This is nature's biodiversity, or nature's monoculture, (91% fir)

PART 2

FLOOD

A large landslide of February 1890 on Marlow Creek. Note: it was preceded by a stand replacement event. In November 1996 this stream again experienced new wood and spawning gravel and continues to be a very productive Coho stream.

Pioneers and Incidents

Herald Extra

It has been ascertained that the rapid raise in the river last Friday and the immense drift that came down at the time was caused by land slides coming into the river from the mountains on both sides on the South Fork just below Rowland prairie and also a stupendous land slide near the mouth of Salmon creek which joins the South Fork near John Wagner's place at the North Carolina settlement. It has been said that a whole side of a mountain of fir timber slid in, when it gave way water raised 25 ft. in the valley and left drift in the top of Wagner's orchard when it went down.

Floods, Slides and Losses On East Coquille

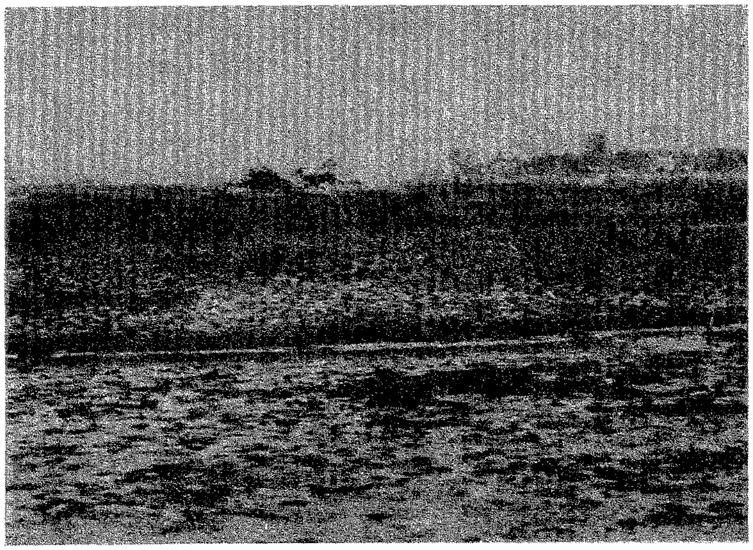
Mr. Miles Simpson just in from Dora tells us of the damages of flood and slides in his part. A couple of young men who came over the road reported 4 land slides in the canyon of the Coos Bay road. Another one occurred at Jas. Laird's that carried away a part of his house—a room used for a wash house. The slide carrying boulders weighing as much as 3 tons, but a big rock back of the house parted it and it circled and came together below the house again, leaving the front yard full of big rock. The slide was over half a mile long and shook lamps, dishes, etc. off the shelves and tables. The road is wrecked all about, but the bridges were not badly injured. The bridge at Minard's mill lost one approach and 2 bents were carried out of the one at Gravel Ford. A large slide was threatened at Mrs. Hobson's place and she had to leave.

Coquille City Herald, Feb. 14, 1890

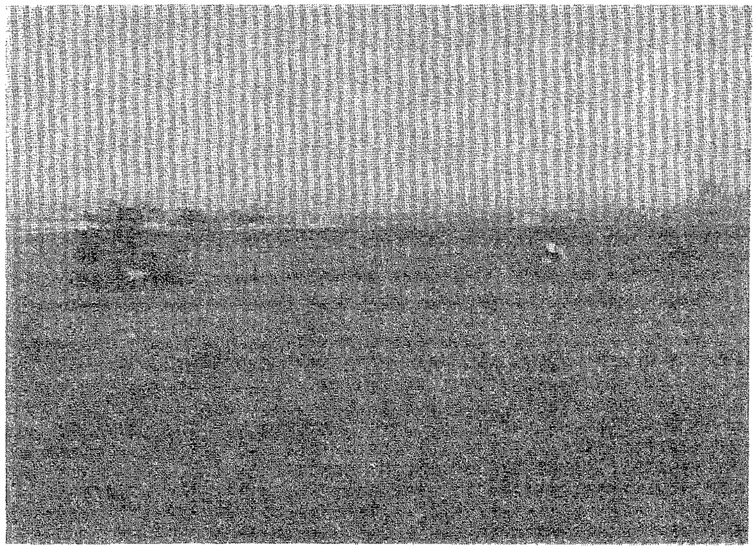
Stock Escapes Big Slides

Steve Reed the Eckley mail carrier came down Saturday and reports that he has seen nearly all the stock raisers in that direction who say there has been but little stock lost as yet. Jack Sears has pulled his excellent herd through with no more than the usual loss. J. W. Caldwell has also had good luck in saving his and in fact all of the stockmen as far as we can learn have reason to be glad. This proves that Coos and Curry counties are excellent for that branch or industry. Steve reports that there are many slides along the trail that in magnitude eclipse anything that has ever took place in that line in the country. The Bald hill near Rowland prairie is cracked in many places on the surface and at other places whole sides of mountains have slipped down thus changing the appearances of the country considerably. Eckley had no news from Salmon Mt. and it is feared that heavy slides have done much damage in that vicinity. Our informant is a very reliable carrier of U. S. Mails for which the people of Eckley should rejoice.

—*Coquille City Herald*, Feb. 11, 1890

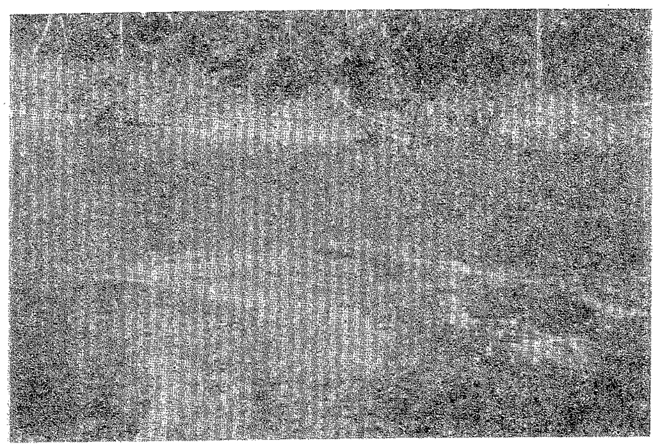


Old spruce logs still evident in Siletz Bay, a result of the February 1890 storm when everything that could slide, did.

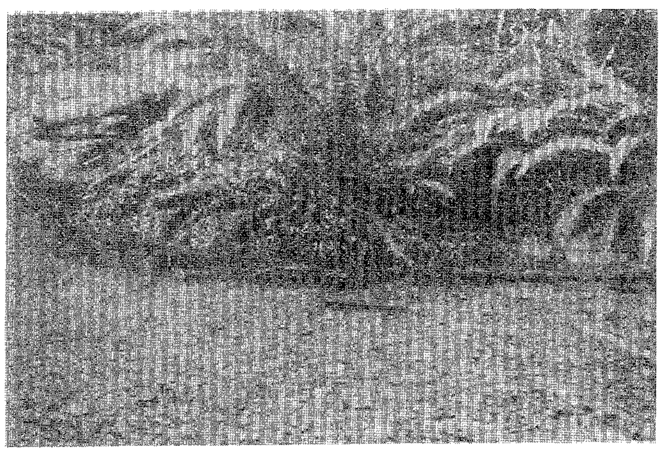


Another view of Siletz Bay on the central Oregon Coast.

Debris from November 17th storm, holding in check spawning gravel. West fork of the Millicoma River.



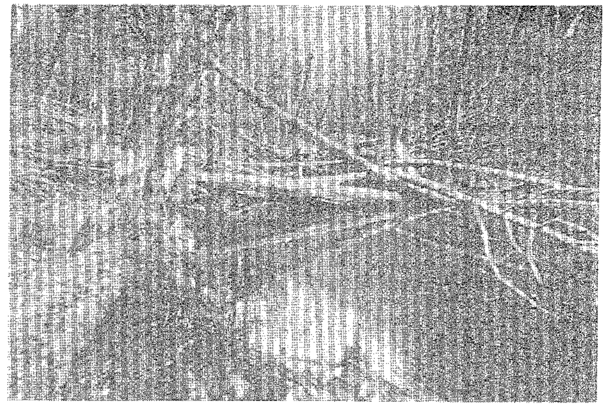
Two Coho Salmon spawning December 10th. 3 weeks earlier, this area was only bedrock.



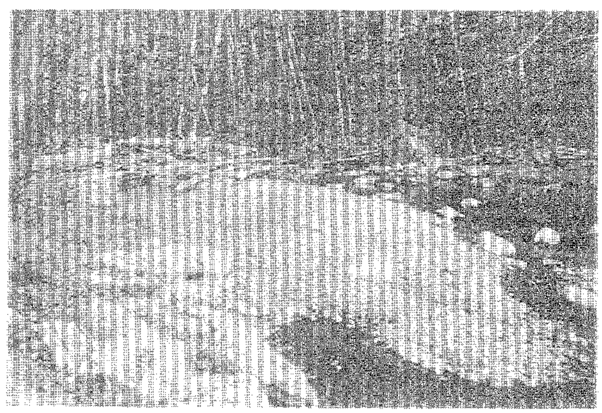
Again, Coho salmon spawning in gravel produced by the November 17th 1996 storm and held in check by wood from the debris slides of that 100- year event.

The source woody debris is a side stream with steep slopes. Timber left on these steep head walls (60% or greater) with a probability of reaching a fish-bearing stream has a potential of producing essential habitat.

Down wood left in these same areas at the time of harvest would possibly produce even a greater probability.

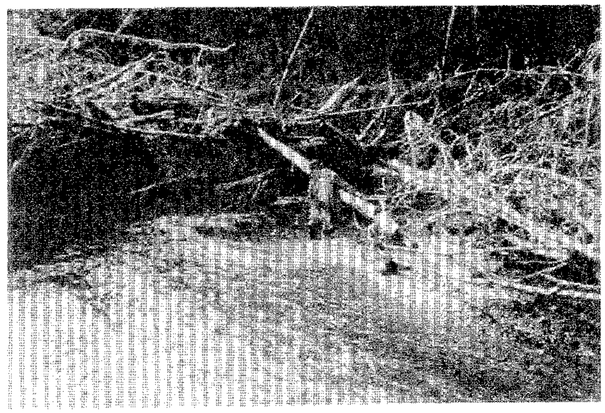


Cougar Creek
November 1997



Creek
November 1997

Coos Watershed Association
P.O. Box 5860
Charleston, OR 97420



Marlow Creek
November 1997

Marlow Creek
December 1997

Coos Watershed Association
P.O. Box 5860
Charleston, OR 97420

CONCLUSION

In view of the historic and scientific data confirming the types of disturbances necessary to regenerate Douglas Fir forests and rejuvenate anadromous streams, we must move forward within the matrix lands in the Northwest Forest Plan to implement a harvest program within the intermittent stream buffers that will closer simulate nature.

This will not only improve the long-range health of the forest, but will provide jobs, revenue for local services, and the resources for affordable housing.

This information must change the way we view regeneration harvest and land slides in the Douglas Fir region of the Pacific Northwest.

Testimony of
R. Neil Sampson

President
The Sampson Group, Inc.
Alexandria, VA 22310

before the

Subcommittee on Forests and Forest Health
House Resources Committee

Oversight Hearing on the
General Accounting Office Study on Forest Health

September 28, 1998

Madame Chairman. Members of the Subcommittee.

I am R. Neil Sampson, President of The Sampson Group, an Alexandria, Virginia consulting firm that specializes in natural resource issues such as forest health. I am also a Senior Fellow with American Forests, the Nation's oldest citizens conservation organization, and an Affiliate Professor with the Department of Forest Resources at the University of Idaho. My resume is attached to this testimony, as requested by the Subcommittee.

I co-authored a small book, "Forest Health in the United States," that was published in 1998 by American Forests. Copies have been provided to the Subcommittee members today. While my testimony stems from several studies I have done in cooperation with American Forests, it is my professional testimony and not an official position of that organization.

I have been aware of the general approach taken by the General Accounting Office in its study on forest health, and have provided them with some reference materials, but I was not made aware of their testimony or findings, so the following material relies on studies that I have conducted utilizing the available literature and my own observations.

The forests of the Inland West have been a focus of my interest for the past decade, when it became clear that the drought of the 1980's was causing forest stress of a kind that had not been experienced during earlier drought periods. It was relatively easy to determine that it was not the drought that was different; it was the forests, and their ability to tolerate the stress. A cooperative research program was launched in southwestern Idaho, centered on the Boise National Forest, that sought to determine what was happening and why. At the same time, I chaired the National Commission on Wildfire Disasters, which was preparing a report for the Congress.

We reported some of our early conclusions to the Congress in 1992, as follows:

> There are widespread forest health concerns in many regions of the country today, but there is an emergency in parts of the west, and we believe it is important to move immediately to address it. Our comments are directed at the forests lying east of the Cascade and Sierra peaks, running east to the Great Plains. They encompass several Forest Service regions, and the specific conditions may vary widely, even though most are suffering from many of the same general problems.
>
> It is time to get beyond "business as usual" on many of those forests, because the risks of major environmental, economic, and social disaster are growing, and the actions being taken so far are not even beginning to keep up with a worsening situation. It is past the time for studies and reports. It is time for action.

That testimony, and other supporting observations at that time, contributed to an enormous political controversy over forest health that continues to this day. What it could not launch, because of that controversy, was a positive policy and action response. As a result, millions of acres of Western forests continue to be at high risk of wildfire.

Since June 30, 1992, when the above testimony was delivered, the 11 western states have experienced somewhere around 12 million acres of wildfire and the federal government has spent over $2 billion in suppression activities. On the Boise National Forest, where many of our forest health studies were centered, and where the concern for the future of the forests was very high, around 300,000 acres of forest have been affected by wildfire since that testimony was delivered to the Congress. That represents something like 25% of the total ponderosa pine forest on the Boise, and some of it has been impacted so severely that the likelihood of a pine forest recovering is very slim. I believe events have demonstrated that we were not wrong then, and that it is not wrong to continue to call attention to the need for better management action today.

Federal policies on the use of fire, and on the treatment of high-risk forests, have changed in the past decade, but the sad fact is that millions of dollars have been spent on studies to essentially reinforce the scientific conclusions that were reached in the early 1990's, while work to identify high-priority areas and treat them to reduce risks has been slow in starting.

The thinking about forest health has changed considerably in the past decade. Concerned primarily with insect and disease damage to trees for many years, the topic has been evolving into a much broader consideration of the condition of the total forest ecosystem. Some people insist on using the term "forest ecosystem health," but since most of us consider the term forest to indicate a complete ecosystem, that often seems unduly redundant.

In the publication provided to you today, Lester DeCoster and I identified six broad trends that we feel have altered forest ecosystem processes in ways that can have long-term negative impacts. They are also trends that can be traced directly to human-induced changes, and which could, with varying degrees of effort, be altered so that forests would be less adversely affected. In other words, these are things we could change. Not easily, in all cases, since they reflect some strongly-entrenched factors in today's American society and economy.

The six trends we identified are:

1. Altering the fire regime, largely through a century of grazing, logging, and fire suppression.
2. Forest simplification, caused primarily by large-area protection or fire suppression efforts that have resulted in essentially uniform vegetative and structural conditions over unusually large areas. This creates a problem for species that require different forest structures for habitat, and the risk that a large region will be uniformly affected by a disturbance like a wildfire or hurricane, creating a future dominated by large-area conditions rather than a more diverse situation.
3. Forest fragmentation, the reverse effect, caused by chopping up the forest into such little, diverse pieces that species and processes requiring large landscapes are eliminated or placed at risk.
4. Introduction of exotic species such as cheatgrass and kudzu, that crowd out native species.
5. Changes in chemical composition through airborne emissions of biologically active compounds such as carbon dioxide and compounds of nitrogen and sulphur.
6. Unusually high populations of particular animal species such as deer or elk that can dramatically alter forest vegetation.

These situations do not affect all forests, of course, and do not affect them equally across the country. Nor are they of equal seriousness, at least in terms of what scientists know today about their potential effect. Each has the effect, however, of changing the way forests function at the ecosystem process level, and those changes may or may not lead to forests that are sustainable.

In my professional opinion, the situation the most significant threat, in terms of potential environmental and economic damage, is posed by the change in fire regimes that affects Western forests. This situation is likely to result in billions of dollars in resource damage, fire fighting costs, lost property, and damaged or destroyed lives within the next decade or so.

Many of these damages are preventable, but only if people and agencies take the actions needed to return high-risk forests to a more fire-tolerant condition.

Those terms are chosen with some precision. You will note that I did not say that wildfires in these forests are preventable. They are not. Not only are fires an important and integral part of the way these forests function, but the conditions that exist today virtually guarantee wildfires so large and intense that suppression efforts are futile.

But many of the damages are preventable. Forests in this region can tolerate fires, so long as the fire burns within the historical range of intensity and severity. Trees and other vegetation may be killed, and forest structures altered, but the long-term integrity of the forest will not be damaged and may, in fact, be strengthened in many places.

On the other hand, when forests burn with extraordinary heat and severity, the damage can destroy long-term ecological integrity. This is a point where some scientists disagree. They argue that, since fires are a natural process in these forests, the damages are only temporary and the forest vegetation and soil will both recover in time.

In some places, that argument is correct. In many of the high-elevation spruce-fir and lodgepole pine forests of the West, it appears that today's fires are within historical ranges in terms of intensity and severity. Thus, the long-term damage to soils is probably non-existent or minimal in most places. The general consensus on the 1988 Yellowstone fires, for example, is that they were larger in area than the historical record indicated, but the intensity and severity were not excessive in most places, and recovery in those areas has proceeded about the way ecologists predicted it would.

I believe it is a mistake, however, to transfer that experience to other forest types across the West. In study after study, forests such as ponderosa pine, east-side Douglas-fir (Douglas-fir growing east of the Cascade crest is much different than the Douglas-fir on the wetter west side which are prized for their old-growth characteristics), and mixed conifers are found to be much further outside their historical range of conditions. In most cases, that means that the amount and arrangement of flammable fuels is such that the next fire will be several times hotter and more damaging than was historically common. These are the forests that are at the greatest risk of long-term harm when they burn.

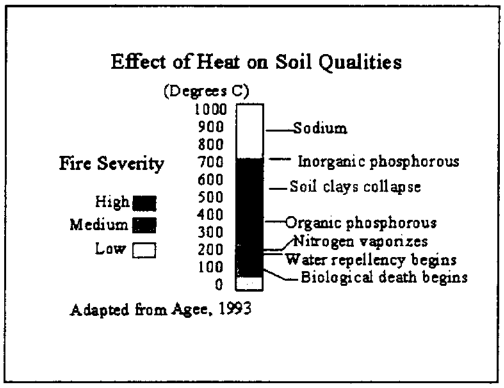


Figure 1. Soils affected by high-severity fires can suffer nutrient and carbon losses that take years to recover. If the soil clays are changed, the effect may be permanent.

While most of the attention after one of these fires will be paid to the dead trees and damaged property, the greatest long-term impact will be invisible, buried beneath the soil's surface. Soils that are heated above 200 degrees Centigrade suffer losses of nutrients and organic matter (Figure 1).[1] If the heat goes above 400 degrees, they can suffer permanent changes in structure and texture.[2] These soil temperatures are almost never reached in a prescribed fire, and do not appear to be common in many of the high-elevation forest fires. Increasingly, however, they are one result of the unusually-hot fires affecting forests such as ponderosa pine and east-side Douglas-fir.

Some soil damages become painfully apparent in the next rainstorm. Soil scientists use the term hydrophobic to describe one such condition. Hydrophobic is a lengthy way to say "water repellent." It happens when surface vegetation containing a high oil and wax content is burned, and the waxy compounds are vaporized. Most of the vapors go up in the smoke, but some are forced down into the soil by the heat. As long as the soil is hot enough, they stay volatile and move through the soil pores. But soil is a poor conductor of heat, so the compounds soon encounter soil layers cool enough to condense them into waxy coatings on the soil particles. In sandy soils, which have less total pore space than fine-textured soils, the pores are soon clogged, and a waxy water barrier is formed. The hotter the soil column at the surface, the deeper this waxy layer will be formed. The more vegetation containing these compounds that is burned, the thicker and more water-resistant the sub-surface layer is likely to become.

These hydrophobic layers will be broken down by organisms and roots over a year or two, but while they exist, the soil is vulnerable to severe erosion in the event of rain. A major storm, soon after the fire, can result in removal of much, if not all, of the topsoil above the waxy layer. The water turns it to mush, and it just runs off the hill. Even a minor rainstorm, if it hits a particularly vulnerable place on a steep slope, can move tons of topsoil.

In one example, the 1996 Buffalo Creek fire southwest of Denver, Colorado, burned almost 12,000 acres of ponderosa pine forest. Because of the fuel and fire conditions, about 2/3 burned in a lethal crown fire with severe soil heating. The rest burned largely as a low-severity ground fire. Shortly after the fire, a 2.5" thunderstorm over the burned area caused soil erosion losses that averaged 1.4 inches of soil removed from the 8,000-acre area of severe wildfire.[3] The resulting floods and mud flows downstream were catastrophic, including one death. At the Strontia Springs Reservoir operated by Denver Water, it was estimated that more sediment (200,000 cubic yards) was deposited in the first flush of Buffalo Creek flooding than had been deposited in the prior 13 years of the reservoir's life.[4] The cost of lost power generation revenues during the time when debris prevented turbine operation, cleaning the wood debris out of the reservoir, and restoring drinking water quality and electrical generation service, was estimated at nearly $1 million in the first clean-up, and the work continues today with each subsequent runoff event. Another continuing cost is created by the ongoing turbidity in the water, which raises treatment costs as well as the cost of disposing of the sludge created by the clean-up process.

In July, 1998, a summer rainstorm in the Buffalo Creek watershed again dumped an estimated 50,000 cubic yards of new sediment into the reservoir. The utility currently estimates that sedimentation from continued runoff and movement of stream channel deposits above Strontia Springs could be in the range of 150,000 tons per year, and continue for many years, if not decades. Removing that sediment currently costs between $6 and $7 a yard, so one storm alone created a liability of almost $350,000 for the water customers in Denver, and the annual figure could average $1 million or more.

These costs, borne by the water users in Denver, will continue to mount up, and add to the millions of dollars the federal government has spent in fire suppression and emergency restoration on the forest. The sad fact is that much of this latter money is wasted, because the soils in many areas have been stripped to bedrock, and the potential for a future forest is bleak.

These soil damages, both in terms of the nutrient and organic matter loss from the fire's heat, and the soil lost to erosion in a post-fire rainstorm, are most ecologically damaging where the soils were thin and marginal before the fire. These poorer soils may not recover for centuries or millennia, if ever. Those who suggest that these are minor damages, and that the soils will recover, would do well to study the areas of the world that have experienced a desertification process that has turned forests into grass or brushland, or barren rock.

The reason for dwelling on this topic is not to sensationalize the risks involved. It is to make the point that forest situations likely to lead to these kinds of impacts can be identified today and prioritized for treatment as a means of preventing the damage. Hydrophobic soil conditions are created when vegetation of certain types and amounts burns on certain soils. The subsequent erosion damage is affected by soil type, slope, and rainfall.

Nobody can predict when the next forest fire ignition will coincide with the weather that will explode it into a high-severity event. What we can do, however, is identify those areas where the existing combination of vegetative conditions, soils, and slopes means that when a fire occurs, it will almost certainly result in severe soil impacts. There's not much that can be done about the soils or the slopes, but the condition of the vegetation can be changed so that the next fire, when it comes, will not burn as hot. We can't prevent the fire; we can alter the types of damages likely to occur.

The tools for identifying high-risk sites and the techniques for treating them are readily available. They are not always cheap or easy to use. For example, current satellite imagery can identify vegetative types, but cannot see under the forest canopy to help map fuel conditions in enough detail to provide the information needed to model fire effects. That takes other techniques, such as field surveys, that are feasible on a watershed or project basis, but not practical over enormous areas of western forests. Work is under way to develop effective large-area methods, but until it is successful, it is not possible to say with any certainty how much high-risk forest exists in the large, remote western areas. We can make general assessments, based on general forest type information, but these are rough approximations at best.

In a recent study completed to evaluate the biomass resource of the West, I identified 68 million acres where large volumes of small-diameter material in ponderosa pine, Douglas-fir, and true fir forests suggest that fuel loadings are exceptionally high.[5]

Identifying high-risk areas within that large area, however, takes a different approach. Here, one must utilize satellite information and other data sets such as general soils information, ignition histories, and slope and topography maps to pick out the most logical areas for the existence of high-risk conditions. These strategic assessments can be very valuable in helping to focus costly survey work on smaller areas, improving the efficiency of planning and prioritizing land treatment approaches.

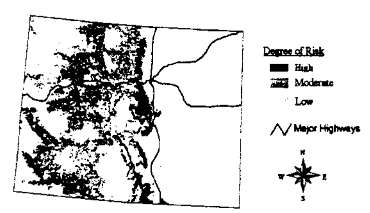


Figure 2. In Colorado, many of the forests at risk to wildfires that are larger or more intense than the historical norm lie along the populated "Front Range" corridor west of the primary North-South highway (I25).

In a recent study centered on Colorado forests (Figure 2), it was clear that the areas in the foothills of the Front Range were at high risk.[6] That included the Buffalo Creek area, and had this study been used as the basis for a more detailed survey, those risks could have been easily identified.

Implementing the needed land treatment on high-risk sites is delayed primarily due to political and economic constraints. The political roadblocks to action on the public forests are shaped by polar arguments, with one side promoting the idea that no treatment is warranted, and that if the land is left alone, it will be better. The opposition argument often sounds like a standard timber harvest proposal, suggesting that by removing the economically-valuable trees, the forest will be healthier.

The polarity between these views tends to lock in positions that are irrelevant in terms of what the forests themselves need. What the forest needs is some combination of treatments, fitted to the particular site and condition, not likely to follow either of the polar "solutions." The political polarity ends in a stalemate where neither side can win, so no solution emerges.

The economic constraints are due to the fact that much of the material that should be removed from the forest has no local market. Much of it is too small or low-quality for traditional wood or paper uses. There are a few local markets for fuel chips, fuel wood, mulch, or other products but, in general, these markets do not come anywhere close to matching the supply of material that needs to be removed. Not only are these small materials from forest health treatment projects not profitable, there are few ways of economically disposing of them. Where the amount of material to be removed is so large that it cannot be burned safely in the woods, the managers face an enormous problem.

Many of us believe that the most readily-available methods for disposing of the enormous amounts of biomass that exist in Western forests lies in accelerating the implementation of biomass energy technologies. The production of electric power through biomass-burning power plants is a technology that is on-line today. Biomass is a clean-burning fuel, and air pollution is very manageable. The problem, again, is economics, because biomass does not compete with fossil fuels such as natural gas at today's prices.

Biomass can also be used to produce ethanol, using a variety of new technologies that have resulted from recent energy research. This technology faces all the risks and uncertainties of being new and untested, however, and will require policy support for the near future.

None of these technologies offer a "silver bullet" that solves the forest health situation, but all of them, taken together, offer an expanded menu of options that can be adapted at the community level to meet the situations in each locality.

That raises several policy challenges for the federal government.

Community solutions are difficult to implement in the West where action depends so heavily on federal lands and their management. Finding some way to implement forest health treatment programs at the community level will be key to the future of many of these forests. Problems can be identified in regional or national studies, but all solutions are local. Somehow, we need to decentralize federal lands policy to the point where locally-developed approaches can be implemented.

Energy policy is focused on deregulation today and while that has many virtues, it offers little promise of helping an emerging technology break through the implementation stage. While it is apparent that renewable energy sources such as biomass are not competitive in today's energy supply environment, it is also apparent that continued reliance on non-renewable foreign energy sources is not an attractive long-term solution. The long-term solutions should rely more on renewable domestic sources, and the task of building the transition toward that more-renewable energy future must start well before it becomes essential. Renewable energy technology is needed today to help solve major problems in western forests and communities, which makes it a worthy policy goal.

Federal land management policy is clearly a major challenge in this situation. It has been demonstrated consistently that the long times, high costs, and administrative rigidity in the current federal planning processes make projects difficult and costly to plan and implement. Timber sale contracts are often ill-suited as a means of obtaining the land treatment that is needed in the high-risk forests. Experiments with stewardship contracting, cooperative management with the states and communities, and locally-developed approaches are ongoing, but the pace is far slower than the situation seems to demand.

It seems clear that federal forests are not faring well under the current situation, and that changes are needed. This is not a new insight, but one that has resulted from a variety of studies. I don't know if the GAO study comes to a similar conclusion, but I'd be surprised if it didn't. Hopefully, the Congress will consider its recommendations carefully, and move toward policies that favor action, instead of continuing the "study and delay" strategy that has marked the past decade.

Thank you for the opportunity to bring these views before the Subcommittee. I'd be pleased to answer your questions.

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1984-1995 -- Executive Vice President, American Forests, Washington, DC.
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1960-1964; 1965-1972 -- Various Field, Area, and State Office assignments with the Soil Conservation Service in the State of Idaho.

Overview: Neil Sampson has developed and directed action programs, done research, and published writings on a broad range of resource management and policy issues connected with agriculture and forestry. He has been active on national and international conservation issues, with a focus on sound, active land and water management based on science, stewardship, and ethics.

As chief staff officer for 11 years at American Forests, he conceptualized and managed the Global ReLeaf program, which won a 1991 Presidential Environment and Conservation Challenge Citation. He conceptualized and helped create the Forest Policy Center as a research center that bridges between the questions policy makers ask and the information developed by scientists and experts around the world.

As Senior Fellow, he designs and directs projects focusing on the science of ecosystem management and its role in helping re-define the impact of human management on the sustainability of natural and human-shaped ecosystems. These include field studies that document environmental impact of various programs and projects, policy analyses, and publications for both public and professional audiences. Recent projects include development of a strategic model for assessing wildfire hazard and associated environmental risks in western wildlands, and an ecological assessment model for use by local planners in an urban-wildland intermix situation.

His international work includes development of a national soil conservation program for The Gambia during the mid-1970's; consulting with leaders in Argentina on agricultural policies in 1983; and, since 1990, working in the former Iron Curtain countries, assisting with the formation of both civil institutions and environmental programs. He has organized and led international workshops on terrestrial ecosystem dynamics and global carbon flows. He has coordinated research on United States forest and forestry conditions, and their relationship to global climate change concerns, and edited two recent books on the topic. He has coordinated the design and implementation of tree planting and forest improvement programs in the U.S., eastern Europe, and South America.

His writings run the gamut from conservation and stewardship ethics to technical assessments of natural resource challenges and development of computer models to portray the information contained in national resource inventories.

He serves on the Board of Directors for the Natural Resources Council of America and Renew America. He serves on the editorial or advisory boards for *Forum for Applied Research and Public Policy*, University of Tennessee; *Earth Ethics*, Greenfire Foundation, Alexanria, VA; and *Eurosolar*, Bonn, Germany. He is Associate Editor of *Mitigation and Adaptation Strategies for Global Change*, published by Kluwer Academic Publishers. He chaired the 1992-4 National Commission on Wildfire Disasters, served on USDA's Forestry Research Advisory Committee from 1994 to 1996, and was a member of the scientific team on the Role of Wildland Fire in Resource Management that supported the 1995 Federal Wildland Fire Management Policy & Program Review. He was a member of the Forest Health Science Panel chartered by Congressman Charles Taylor and co-author of the Panel's report to Congress. He was Technical Advisor to the Utility Forest Carbon Management Program of Edison Electric Institute.

He currently serves as Executive Secretary of the Expert Review Panel to the Sustainable Forestry Initiative, sponsored by the American Forest & Paper Association. The Expert Review Panel is composed of 18 experts representing environmental, conservation, professional and academic organizations. Its role is to provide an independent review of the industry's progress in achieving sustainable management on all the lands it owns and from which it purchases timber. In that role, the Panel is challenged to help translate the social desire for a sustainable future into concrete action in the practical world facing land managers. He is an Affiliate Professor in the College of Forest Resources at the University of Idaho, where he is involved in cooperative research projects with other faculty and graduate students.

He is a member of the Society of American Foresters, the Soil and Water Conservation Society, and the American Academy of Sciences. As an SWCS Fellow, he has been chosen for their highest award, the Hugh Hammond Bennett Award.

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Active in community affairs and Presbyterian church.
Hobbies: woodworking, gardening, music, hunting/fishing/camping
Skills: computer applications for natural resource writing and research (word processing, data base programming, spread sheet modeling, graphics, geographic information systems, communications)

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U.S. House of Representatives
Committee on Resources
Subcommittee on Forests and Forest Health

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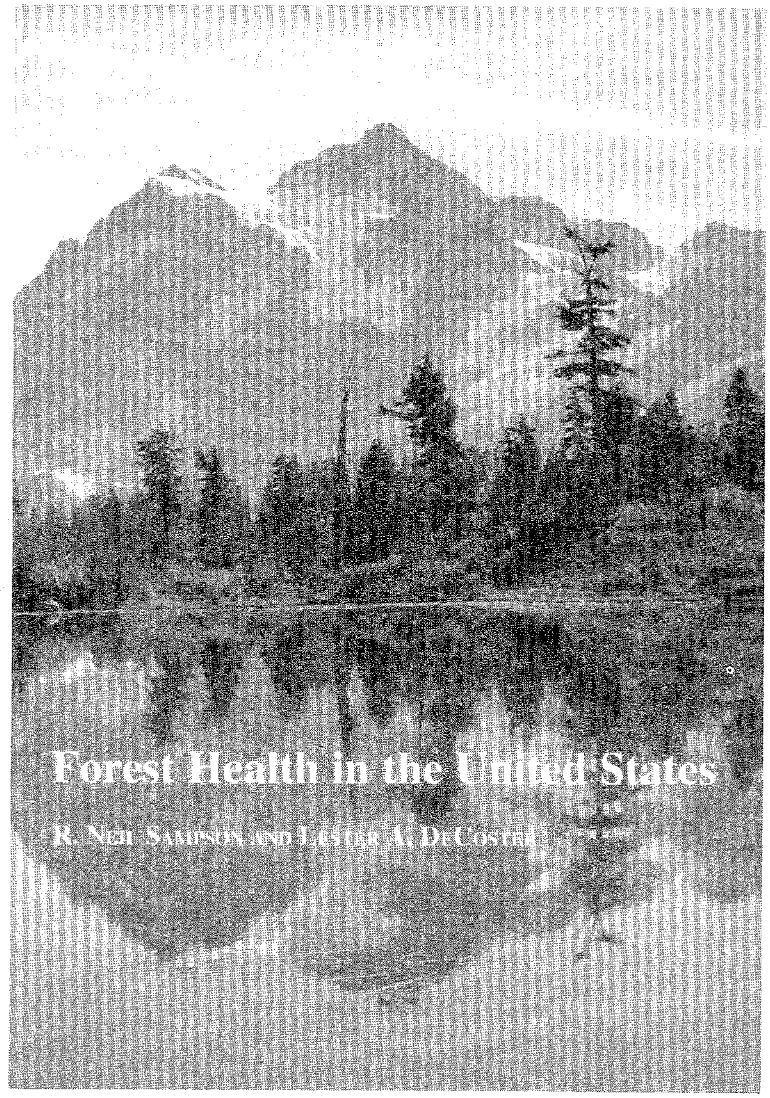
6. No professional licenses or certificates.
7. My experience extends over a 38-year career in natural resource and land use management. See curriculum vitae attached to testimony. It includes chairing the National Commission on Wildfire Disasters (1974) and authoring several professional papers and books on the topics at hand. One of my recent publications is provided to the Subcommittee members as part of this hearing record.
8. President, The Sampson Group, Inc.
9. American Forests, with whom I have been affiliated in a variety of ways since 1984, has been the recipient of federal grants, contracts, and cooperative agreements. Some of the research work I have done in the past was partially supported by those agreements. Since I am not representing American Forests, however, and left the paid employ of the organization in 1995, this does not seem germane.
10. The Sampson Group, Inc., has not been the recipient of any federal grants from USDA.
11. The curriculum vitae seems to cover it adequately.


Forest Health in the United States
R. Neil Sampson and Lester A. DeCoster

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Neil Sampson became a Senior Fellow with the Forest Policy Center after serving 11 years as the executive vice president of AMERICAN FORESTS (formerly the American Forestry Association). Prior to that, he served 6 years as executive vice president of the National Association of Conservation Districts and 16 years in a variety of positions with the USDA Soil Conservation Service (now Natural Resources Conservation Service) in Washington, DC, and Idaho. He holds degrees from Harvard University and the University of Idaho.

His research and writing covers a wide range of natural resource topics, with hundreds of articles and book chapters. He has written two books on soil conservation, and co-edited several books on natural resource topics. In addition to his work with the Forest Policy Center, he is President of **The Sampson Group, Inc.**, an Alexandria, Virginia, consulting firm that helps clients identify common-sense solutions to natural resource challenges. He is also an Affiliate Professor in the Department of Forest Resources of the University of Idaho's College of Forestry, Wildlife, and Range Sciences.

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In spite of their good help, there are no doubt still errors for which we must take full responsibility. We are also responsible for the conclusions and recommendations herein, as none of them were reviewed or adopted by any organization.

Graphic editing was by Dianna Sampson, and copyediting, design, and production was by Eric Sampson. Michelle Robbins provided a final editorial review. Several people provided the photographs that appear throughout. See Appendix C for photo and map credits. In addition, we would like to single out Frank Carroll, formerly with the Boise National Forest and now with Potlatch Forests, for assembling so many outstanding photographs from the files of the Boise National Forest.

Forest Health in the United States

by
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for the
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Contents

Preface

Forest Health in the United States. The title conjures up an array of issues concerning the condition of our Nation's forests—their sustainability as functioning ecosystems; their capacity to provide a multitude of environmental, social, and economic values; and their susceptibility to threats from natural disturbances and human activities. In this publication, authors Neil Sampson and Lester DeCoster try to reconcile some of these issues and provide information to help improve understanding and encourage public dialogue.

Over the past decade, forest health has emerged as a critical forestry issue across the Nation. But it is one that has different implications in different parts of the country. As forest science and management have moved toward an ecosystem-based perspective, and as social values have shifted toward an increased recognition of the environmental and amenity values of forests, the concept of forest health has evolved, becoming broader and more complex. In effect, the issue has become more controversial.

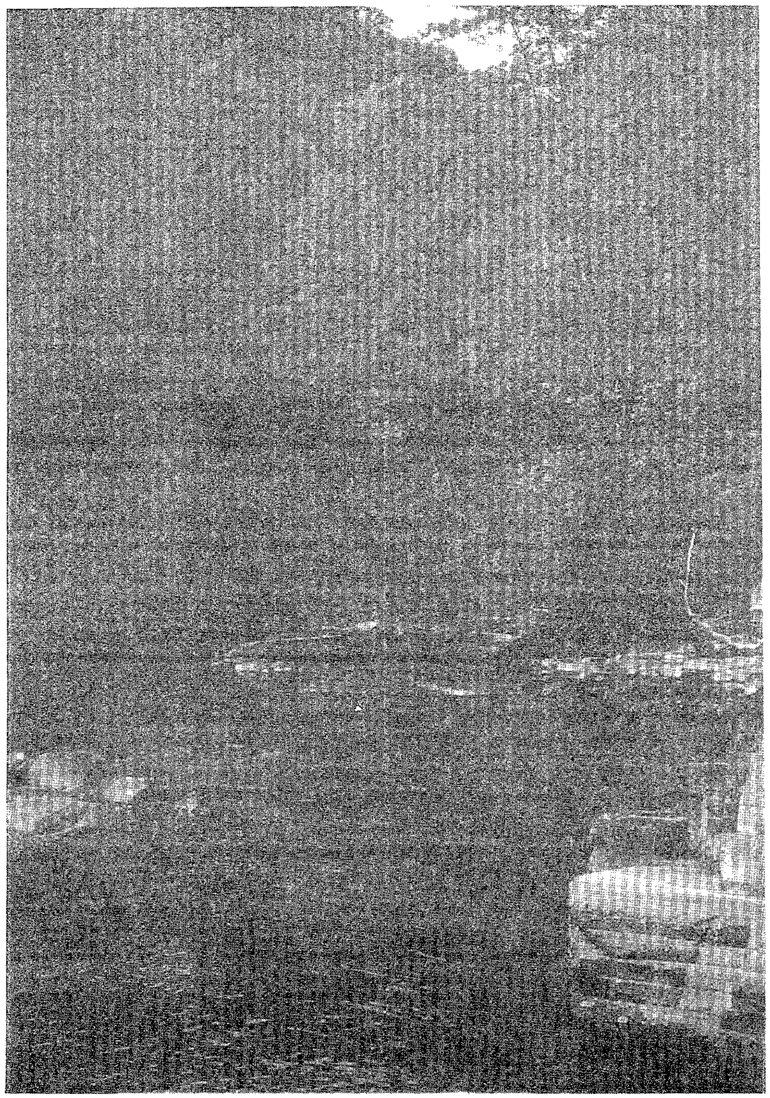
In preparing this report, the authors took on a daunting challenge: to discuss complex forest health concepts and issues and present information on conditions and concerns in the diverse range of forest types and regions across the U.S. As the authors and several reviewers noted, it might have been easier just to write a book. Nevertheless, the result is a publication that is highly informative and accessible to scientists, resource managers, policymakers, and citizens alike.

This is one of a series of publications that AMERICAN FORESTS' Forest Policy Center has sponsored over the past five years through an initiative focused on developing information and building public understanding of the forest health issue. Like the earlier publications, this one takes an ecosystem-based perspective, grappling with the technical and political complexities of the transition to ecosystem management. The earlier reports, however, dealt with forest health issues in the Inland West, a region on which much of the national policy concern has been focused. This publication builds on the scientific and policy information from those reports but expands the scope dramatically, examining the concept of forest health from an ecosystem-based perspective in other regions of the country.

Although the authors have generally prepared a publication that is objective and balanced, as with any publication, their voice occasionally comes through. Their views do not necessarily reflect the perspectives or positions of AMERICAN FORESTS.

We believe that this publication makes an important contribution to the growing set of studies and reports on forest health across the country. We hope it will help build common understanding and strengthen dialogue on this critical issue among diverse audiences and interests.

Gerald J. Gray
Vice President for Forest Policy



Introduction

We all want healthy forests. But what, exactly, is a "healthy" forest? Would we necessarily know one when we see it? The fact is, forests exist in various stages of physical reality, and whether or not we view different conditions as healthy is often based as much on our desires and interpretations as on any empirical evidence. So forest health is largely in the eye of the beholder, which makes for a difficult debate. How are we to agree on what constitutes a healthy forest when for all practical purposes none of us are looking at the same forest?

The difficulty of defining forest health ensnares both professionals and the general public, since we all harbor feelings (often very strong ones) about what we want from them. To make things more confusing, forest conditions are complex and seldom permanent. Forests go through many stages as they become established, change through the growth and aging of the dominant trees, or are dramatically affected by a disturbance like fire, flooding, or windstorms (Ehrenfeld 1992). All of those conditions may, at one time or another, be part of the natural dynamics within a healthy forest. Or they may be a sign that something is terribly wrong. Knowing the difference may tax the best knowledge we possess.

We also have trouble establishing a clear notion of how humans should interact with the forest. Again, it is a clash between different perceptions and desires. For example, there is an oft-expressed sentiment that forests should be left entirely alone, that "natural conditions" are best. This "let-nature-take-its-course" idea persists although it has been generally rejected by the scientific community as impractical and possibly destructive in some cases. Similarly, the status quo—that is, how our forests are currently being managed—may not be optimal either.

Science increasingly views all ecosystems (including forests) as constantly in flux and always affected by human activities. In fact, much of human history is intertwined with the development of the forests. In short, we are as much a creature of the forest as the whitetail deer, the great-horned owl, and the dog tick. And, the forests that have developed over time have been shaped by the people in them, as well as all those other critters. Therefore, it is naive to say "get the people out of the forest!" That's probably not realistic—or good—for either the people or the forests. However, there are certainly biological and ecological changes taking place today that represent a very real deterioration of the forest environment. Therefore, it would be equally nearsighted and foolish to say "stay the course!"

For our purposes, "forest health" means *"a condition of forest ecosystems that sustains their complexity while providing for human needs"* (O'Laughlin et al. 1994). This definition encompasses the complex interactions of biological processes and human judgments that enter into discussions of the concept called forest health.

The definition also recognizes, as former Forest Service Chief Jack Ward Thomas often points out, that a forest's health needs to be judged within the context of peoples' expectations for it. Not all places can—or should be expected to—produce the same mix of values, and if a forest's condition allows it to sustain itself and produce a mix of values deemed to be appropriate, most people would recognize that as a healthy condition.

We also want to make it plain that healthy forests are produced by *entire systems*, not just trees. As Forest Service Chief Mike Dombeck recently reminded a Congressional committee: "A healthy forest is one that maintains the function, diversity, and resiliency of all its components, such as wildlife and fish habitat, riparian areas, soils, rangelands, and economic potential . . ." (Dombeck 1997). But trees—the most visible and dominant structures in a forest—are often the focus of attention, particularly when political debates break out about how to handle certain situations, a post-wildfire timber salvage, for example.

While much of the controversy may focus on trees, much of the value of healthy forest ecosystems lies elsewhere. As ecologist Robert Costanza and others have pointed out, the services provided by all ecological systems (not just forests) are so critical to the functioning of the Earth's life-support system that if those systems failed, the world's economies would tumble (Costanza et al. 1997). Forest ecosystems comprise one-third of America's land, and productive forests represent a major part of many regional economies, making forests that function in a healthy and sustainable condition critical to the continuation of a functioning society.

It follows, therefore, that healthy forests ought to be *sustainable*, insofar as we can define that goal. One definition of sustainable forest management is "to meet the needs of the present without compromising the ability of future generations to meet their own needs" (AF&PA 1997). That borrows the concept of sustainable development introduced by the United Nations Commission on Sustainable Development, often called the "Brundtland Commission" after its chair, Norwegian Prime Minister Gro Harlem Brundtland. The idea of sustainability is completely consistent with the forest health definition, because any forest that cannot "sustain its complexity," cannot "meet the needs" of either present or future generations.

We call what people do in relation to forests "management," whether it is intentional or not. In many discussions, management is a term for actions such as harvesting timber or planting trees. We believe, however, that many other human actions are of great importance in affecting forest condition and health. When people remove human influence from an area, suppress fires, introduce an exotic species, alter hunting or predation rates, or inject chemically active materials into the environment, forests are affected. Some of these actions may be an attempt to preserve a particular forest condition that people value, but most are taken with little or no thought of how forests will be affected.

Often overlooked in the forest health debate is the importance of experience. Native Americans observed their forests for thousands of years, learning to use management tools like fire to create the type of forest they desired. What those early Americans learned, they passed down from generation to generation (Cronin 1983; Pyne 1982). In contrast, modern American society has only had a few hundred years to interact with the forest. We've learned much, but we increasingly recognize the need to speed up the learning process with the best science and prediction models we can develop. We may not have the luxury of another 500 years to learn how to manage these complex systems sustainably.

We will illustrate some of the concepts, tools, and management techniques currently being used to maintain healthy forests or restore those that are in deteriorated or hazardous conditions. As good as some of the current practices are, newer science and further experience will teach new lessons, and good managers will adapt their techniques when they see the need.

As Americans we need to realize that, to some extent, we are all managers of the forest. When people recognize a forest condition that threatens to render that forest unsustainable, they are ethically bound to do their best to remedy that problem. In spite of all the disagreements over how to manage our forests, we can all agree that these are real places, with real living organisms, going through real changes. It may take longer than our lifetimes for the results of these changes to become apparent, but the forests themselves are ultimately going to teach us what is sustainable and what is not.

Each generation, therefore, is responsible for using the best techniques it knows. Obviously, debate will continue on what techniques are "best" in any given situation. Therein—particularly in the case of the public forests—lies the exercise in discussion, debate, and democracy that envelops the question of forest health.

Our Approach

This publication outlines some of the major trends driven by past and present human activities that are likely to be at the root of forest health problems. It also examines different regions of the country and forest types where these problems are most evident. The goal is to help professionals and citizens discuss forest conditions more broadly, and reach consensus more readily about what, if anything, should be done to change the way people are interacting with forests. We will not present specific assessments of any particular forest area, which is better done by those familiar with local conditions.

The discussion of forests will follow an ecosystem-based approach. The ecosystem definition used will be the forest type—areas where the plant communities are similar enough to be lumped into one general category (see pages 42–44). People will be regarded as part of those ecosystems, and the ways in which they inhabit, affect, own, and use forests will be used as a defining feature of forest health, one we can alter when we agree on the need.

It is difficult to accurately generalize the condition of the Nation's forests, or the forests of any region. Consider a parallel to human health. The U.S. population is growing, and individuals are, on average, living longer. Those two facts suggest that the U.S. population is healthy and robust. But to assert that people in this country are, therefore, generally healthy would overlook a host of illnesses, risks, life-style choices, and other potential threats. So, within a growing and robust population, there are areas where people need to pay attention, to be vigilant, and get help when it's needed.

Our forests are in much the same condition. Total forest area is stable and total forest biomass is increasing. Forests are healthy and green in many areas, replete with animal species that were, in some cases, all but gone a century ago. With examples of forests in robust health in virtually any region, America's forests could be portrayed as a healthy, thriving resource. But that would overlook localized or regional concerns that are very real. In some cases, such as the long-needled pine forests of the West, the concerns are more than local and the appropriate response is a matter of serious national debate because many of the problems occur on federally managed lands.

Because the forests can be *characterized* as healthy, however, makes starting the necessary debate tricky. The best time to prevent many forest health problems is when forests still look healthy and robust, but that will also be the time when opposition to biological manipulation—particularly on federal forests—will be at its highest. When political opposition is severe, managers may be prevented from applying needed treatments to prevent major disturbance or ecological setback. It is an impasse that deteriorates both the condition of the forests and the credibility of the managers.

Forest managers tend to rely on science to prevail in these debates, but according to Nelkin (1992) "*. . . acceptance of the authority of scientific judgment has long coexisted*

with mistrust and fear. And there's a common view that seeing humans and nature in scientific terms is immoral."

We realize, therefore, that debates over forest management aren't going to be settled by simply applying more scientific argument—information is always helpful, but seldom pivotal. Forest health debates, particularly as they affect the federal lands, will be public debates, often revolving around the question of "which values are highest priority on these particular forests?" That type of question defies a scientific answer; it can only be answered through public debate that arrives at a consensus. Thus, many questions of forest health are as legitimately political as they are scientific, and the proper role of science is to provide useful information to that debate, not settle it.

The information presented here is based on the work and opinions of dozens of scientists, forest managers, and citizen observers. We have not, in the interests of keeping the publication readable, cited those sources as extensively as one would do in a scientific publication. The list of references and further reading suggestions in the Appendix should help any reader who wishes to pursue these topics further.

Despite these admitted deficiencies, we hope that a continued effort to broaden the discussion of how human activities affect forest health—and to link that discussion to the constantly evolving scientific understanding of how forest ecosystems function—will help bridge the communications gap among professional land managers and scientists on the one hand, and between professionals and the various public interests on the other.

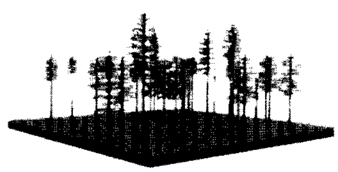
Forest Change

Forests are dynamic associations of living organisms that undergo constant change. By definition, they are plant communities dominated by trees, which provide the main physical structures and carry out most of the primary production (conversion of sunlight energy, air, water, and minerals to food through photosynthesis) in the system. Most of the forests in the northern part of the U.S. have developed since the retreat of the glaciers some 10,000 to 14,000 years ago. Thus, their development is closely allied with the arrival and growth of human populations, which began about that same time. As the glaciers melted, great floods and windstorms shaped the landscape, and species (including trees and other plants, animals, and humans) migrated into places that became available and hospitable to them.

People shaped their environment by hunting animals, harvesting plants for food, medicine, fuel, and building materials, and by using fire to create openings, change grazing patterns, affect hunting, and protect themselves from enemies or wildfires. The forests changed in response to species migrations, climate changes, and human influences, as well as in response to natural disturbances such as wind, temperature extremes, and fire.

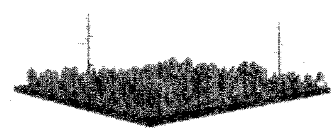
Forest Type

Different forest structures can be defined in many ways, and exhibit somewhat different characteristics in different forest types, but for this report we will use five general structural types to describe forest conditions (Oliver et al. 1997). They are:



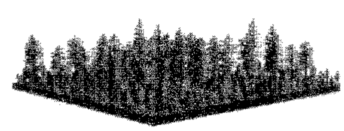
Savanna—often described as "park-like," or "open old growth," these forests have large, widely spaced trees with open forest floors that are often covered with grass or small shrubs. Pioneers were describing these when they spoke of forests so open that wagons could easily be driven through them. Savanna conditions are maintained by low-intensity fires that burn through the grass and fallen litter every few years. These fires kill small trees, but rarely harm the larger ones, particularly those that have thick bark or other defenses against heat damage. A wide range of plant and animal species exist in savanna forests, and some (such as the red-cockaded woodpecker) depend heavily upon it. The plants that succeed under savanna conditions have developed ways to tolerate fire, and some species have become dependent on fire as a means of triggering seed germination or other reproduction cycles.

Open—these are forest openings where grass, shrubs, or small trees grow. Often they are the result of fire or (in modern times) timber harvest. Where trees become established and dominate the site, these openings soon convert into dense forests. A wide variety of animals are attracted to the food supplies produced in forest openings, and where these openings join more closed forests that provide hiding cover and shelter, the "edge effect" of food next to shelter draws many species.



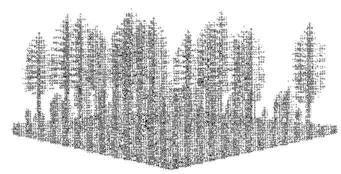
Dense—areas where trees have crowded closely together as they grow larger. When the tree canopy becomes so dense that it fully shades the soil surface, fewer plant species are able to grow on the forest floor. Dense forests, while providing hiding cover for some species, have the fewest associated species of any of the structural types because of the deep shade and strong competition provided by the trees. Competition eventually begins to cause tree death, which can either be partial and serve to open the forest up into the next successional stage, or near-total, which sets the forest up for wildfire.

Understory—areas where the trees are less crowded, and an understory of grasses, shrubs, and small trees grow on the forest floor. This happens where individual trees or small groups begin to die out in dense stands, and light can filter through the tree crowns. One challenge facing managers of today's dense forest structures is to get some of them to this stage before a major distur-

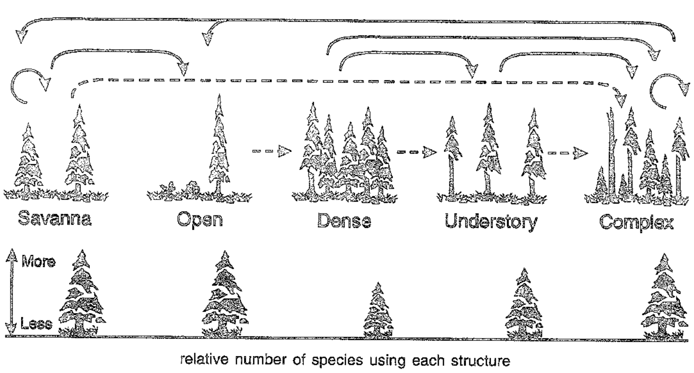


bance kills all the trees in the dense stand, returning it to an open condition.

Complex—areas containing a wide range of sizes and species of trees, as well as dead snags, downed logs, shrubs, and nonwoody vegetation on the forest floor. This is often referred to as "old growth," but savanna and understory structures can also contain large, old trees.



One note about "old-growth" forests. Scientists have long recognized that all forest types go through several structural stages as different trees become established, grow, compete with each other for space, water, nutrients, and sunlight, and then die. This process, called *succession*, takes place in reasonably predictable patterns, driven as it is by the growth and aging of the keystone tree species. Early ecologists theorized that most forests proceeded through these successional stages until they reached the final, or climax stage where they remained more or less in equilibrium. Much of our popular vision of forests is based on this early theory, and many therefore conclude that if we leave a forest alone long enough, it will settle into a relatively stable condition, often called "old growth" or "ancient forests." To avoid debates over "how old is old?" and "aren't there large, old trees in other structures?" we have called this condition a "complex" structure, after Oliver et al. (1997).

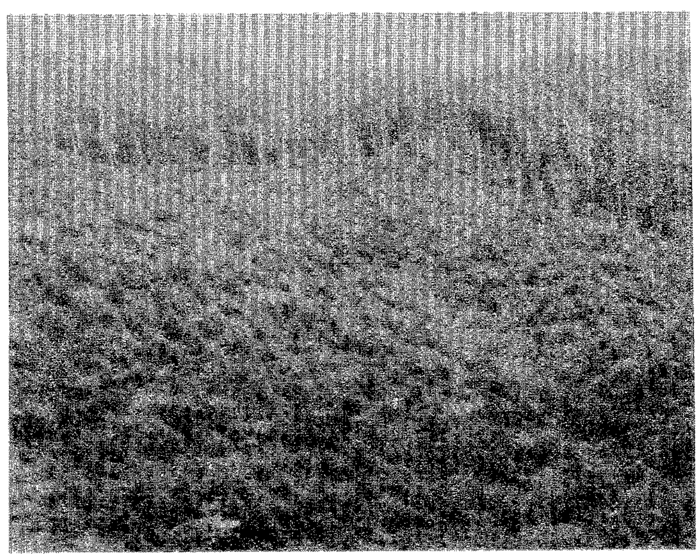


Changes in stand structure following growth (dashed line) and disturbances (red line).

More important, however, is the fact that most modern ecologists have abandoned the idea that "climax forest" represents a state of equilibrium (Botkin 1990). Instead, it has been shown that the most common forest condition is for portions of a forested region to be affected by a major disturbance event, such as a windstorm or a fire, which can either burn on the ground and kill young trees or burn in the tree canopy killing the large trees. Rather than reaching a common "old growth" stage across large areas, it is now generally agreed that forests—before they were affected by human-driven forces—had a mixture of different structural conditions across the landscape. These forests' diversity kept isolated disturbances from becoming wide-scale disasters. It also provided a variety of forest environments to which different groups of soil organisms, plants, animals, and people became adapted. Thus, the diversity of forest conditions across large areas becomes a major contributor to the biological diversity of a region, and to its ability to provide the different habitats needed by the full range of species.

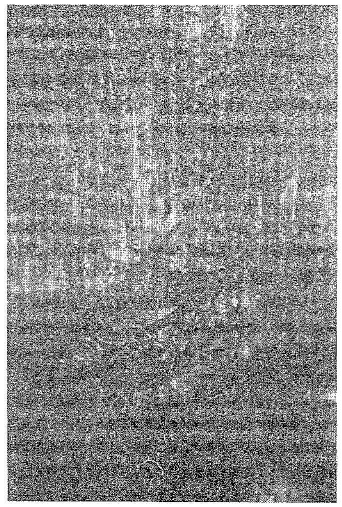
Management and Nonmanagement

Modern forest management changes forests significantly through tree planting, timber harvest and other silvicultural manipulation, road building, fragmentation, and fire management. Management aimed at timber production has cleared forest areas through clearcutting (creating open structures), planted trees (hastening succession), maintained



Clearcuts create open structures and rapid reforestation, but they can introduce fragmentation and harm aesthetics.

low-stress tree growth conditions through thinning (avoiding some problems with overly dense structures), and harvested trees as they reached economic maturity to restart the cycle (usually avoiding both the complex and savanna structures). Such management may produce excellent results in terms of timber productivity, but it can create large areas that lack structural and biological diversity.



Fire suppression and nonmanagement lead to heavy fuel loads and high fire risk.

Forest management that avoids human manipulation to the extent possible—such as setting aside parks and other reserves—may retain savanna, understory, and complex structures, at least for a while. If the protection includes the elimination of American Indian fire practices (as it virtually always does) and suppression of wildfires (as has been common in many areas), the long-term result is likely to be a forest that no longer has structural diversity. In forests where fire was the dominant disturbance factor, its removal or suppression allows areas to grow thick with small trees and brush, changing species composition, and replacing savanna, open, and understory structures with dense structures. Species that depend on open conditions or fire disturbances may be replaced by species adapted to surviving in the shaded conditions of the dense stands, and total diversity will drop since dense forests have the fewest species in most cases. Satellite images of some of America's most remote wilderness areas now show unusually large areas of uniform forest structural conditions. The associated risk is that a forest formerly disturbed in relatively small patches will become uniformly disturbed over relatively large areas. Species that, in the past, survived disturbances by moving from patch to patch to find suitable habitat may not be able to move the greater distances required by a widespread disturbance.

Forest protection is, of course, forest management. On the other hand, so is forest nonmanagement, where noncommercial forests—recovering from earlier timber harvest or agricultural use—are left totally alone. The results, however, are much the same. Nonmanagement may also create large areas of dense structure. Without natural fire as a periodic disturbance, and with owners who lack an economic incentive to carry out silvicultural treatments like thinning or prescribed fire, these areas can become dominated by dense structures and lack the diversity that could help shield them from future large-area problems.

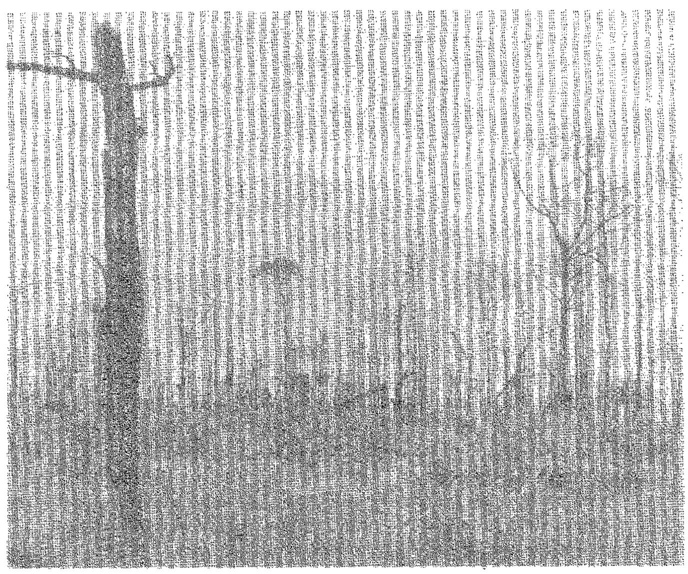
Another important aspect of forest management is the regulation of wildlife populations. Where some wildlife species have been introduced intentionally for sport others have been eradicated to prevent damage. Wildlife management means, for the most part, managing population levels. In the U.S., wildlife management is primarily done by state wildlife agencies that regulate hunting and fishing seasons and bag limits to assure a sustainable wildlife resource. Focusing on a few main species prized by hunters—deer and turkeys, for example—may be very important from the viewpoint of the wildlife agency whose support comes largely from those recreational users. From a forest health viewpoint, however, too many deer may be a major problem. Settling this conflict will call for broad cooperation and compromise between the different agencies and groups involved.

To make matters more complex, the fact is that forest management methods affect wildlife just as much as wildlife management affects forests. Poorly constructed forest roads or ill-designed timber sales can lead to major landslides or erosion that damages the spawning beds of valuable fish species. Removing tree cover from stream banks eliminates the shading that helped keep water temperatures down, and the warmer water may become inhospitable to prized species. Clearcutting large areas of mature forest has been shown to cause a short-term release of nutrients while the site is undergoing the rapid post-harvest decomposition of organic matter due to both the slash on the ground and the additional warmth and moisture in the soil; then there can be a period of several years when the young fast-growing trees effectively capture most of the available nutrients, leaving fewer to "leak" into the streams. These rapid nutrient "fluxes" (high and low levels in the stream) may affect fish populations, particularly if the rapid regrowth period extends for several years on sites that are marginal or deficient in key nutrients, causing stream nutrient levels to fall below the thresholds required by a healthy aquatic system. Again, forest managers and wildlife biologists need to understand these complex interactions and work together to prevent unwanted impacts.

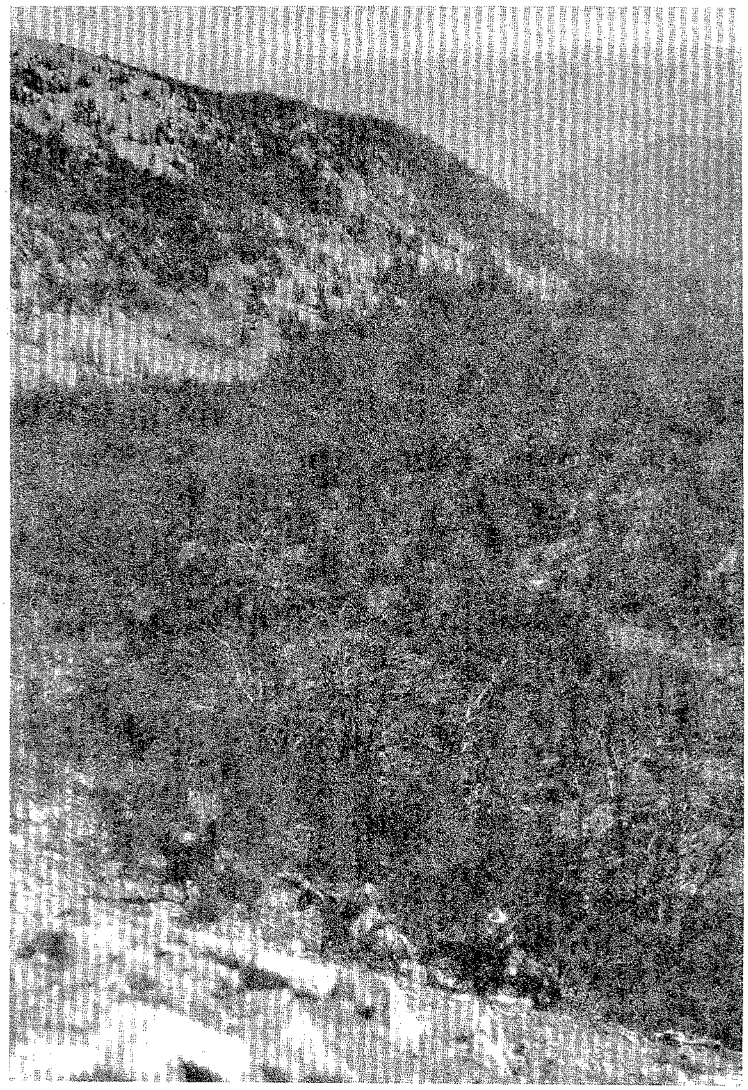
Looks are Deceiving

The evaluation of existing structural stages is one important way to judge the health of a forest system, and the role of people in creating that condition. If a forest region lacks one or more of the structures it historically contained, or a single structure is overly dominant, it may have lost a great deal of its diversity. If this lack of diversity proceeds to the point where some species are suppressed or eliminated because of a lack of suitable habitat, the forest has clearly failed to sustain its complexity and is, by the definition given previously, in an unhealthy condition.

Proving that a given forest region is in an unhealthy condition can be difficult, however. The forest may look green and lush, with trees appearing to be in the prime of health. That such an area is greatly oversimplified in terms of diversity and structure may seem a minor problem at the moment. If these areas go through a period of stress, however, and suffer major dieback over large areas, the forest health problem becomes plain for all to see. The problem is not simply one of green trees being healthy and brown trees being sick. The harder challenge for ecologists and managers is to demonstrate that a problem exists before that dieback occurs, and then find publicly acceptable ways to alter the forest so that the problem is avoided. This is a lot harder than it sounds, and reasonable people can differ greatly on what a certain condition means, and what steps might be taken to reduce the risks involved. People who look at today's very visible problems in the Blue Mountains of Oregon should remember how healthy these places looked in the 1960s; while those who trumpet the recovery of hardwood forests in the East should consider the problems these dense forests may face in the future. As difficult as it is to assess the potential future of a particular place, it is likely to be better to take small steps to steer gently toward a desired future condition than to wait until it is so late that major damage is caused, or major actions (often more subject to overcorrection) are launched.



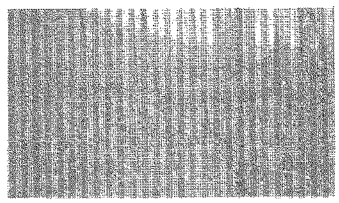
Hurricane Andrew destroyed this pine forest in Tamiami State Park near Miami.



Broad Trends Affecting Forest Health

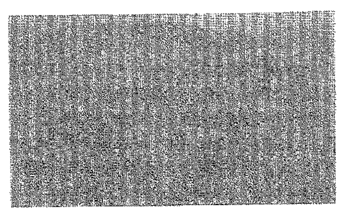
Reviewing the reports of forest conditions across the United States, in context of what we understand today about forest ecosystems, leads to the conclusion that there are six broad trends tied to how people are influencing forests that may significantly affect forest health and sustainability. They are:

Fire—The regular cycling of organic material by fire has been disrupted over large areas, resulting in massive accumulations of flammable organic material. These will inevitably burn if not treated, often so hot that the fire will damage soils and permanently alter the capability of the land to support plants and animals. Rainfall and snowmelt on damaged soils can cause additional soil deterioration through erosion.



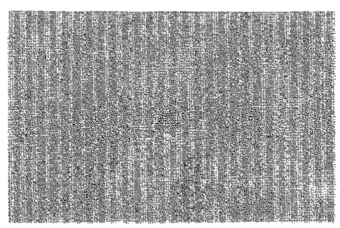
Rabbit Creek fire, Boise National Forest, 1994.

Simplification—Where the diversity of species, as well as the variety of interacting ages and stages, has been reduced across a landscape, the system loses some of its ability to respond to a disturbance. Where large areas are simplified into a few species, a few ages, or a few structural stages, one disturbance can uniformly affect such a large area that it can quickly cause a widespread problem.



Douglas-fir with tussock moth defoliation, Boise National Forest.

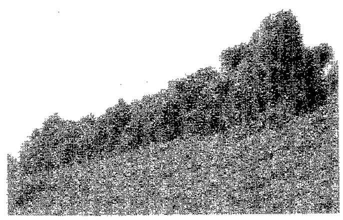
Fragmentation—Large forest ecosystems are being broken up into smaller and smaller pieces—150 million acres of private forest will be in tracts of less than 100 acres each by the year 2010 if present trends continue. This affects the biodiversity of the forest by discriminating against species that need large areas of undivided habitat or less human effects. Small intermixed ownerships also reduce the options people have for managing forests (reducing the feasibility of



Homes and roads break up forest continuity.

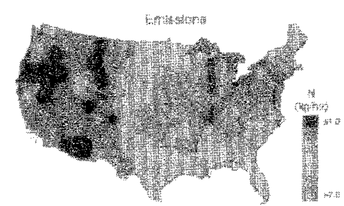
treatments such as prescribed fire and timber harvest, for example).

Exotics—Many exotic organisms are being added to native ecosystems as people and their materials move rapidly around the planet. Some of these result in major species change or loss, as they dominate a system in the absence of natural controls (e.g., chestnut blight, cheat grass, and kudzu), while others may become accepted as a functional part of new ecosystem dynamics (earthworms, urban trees). Some exotics were intentionally introduced for notable purposes, but with unforseen results. Kudzu, for example, was originally introduced to control soil erosion, but grows so aggressively that it can virtually smother a forest. Its control is now a major challenge for many southern landowners.



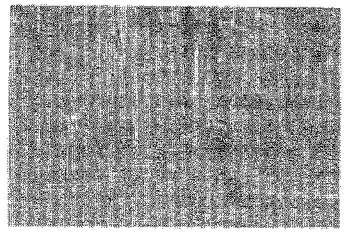
Kudzu covers trees near Norris, TN.

Emissions—Modern societies emit large quantities of chemically and biologically active materials—carbon dioxide, sulphur compounds, nitrate and ammonium, and heavy metals, for example—that are then deposited into forest environments. Scientific agreement on exactly how these compounds are affecting forests is far from complete; that there are some effects, however, seems certain. Measurements by the National Atmospheric Deposition Program (right) show that some eastern forests receive 15–20 times more nitrogen deposition each year than some western areas.



Airborne nitrogen deposition measurements, 1996.

Animals—Very high populations of large forest-browsing animals such as deer and elk are changing the species mix and regeneration patterns of forest ecosystems. Where browsing is heavy enough to alter or eliminate forest floor vegetation, a variety of plants, ground-dwelling animals, and soil organisms are affected. In the Allegheny National Forest (right), deer have eliminated edible browse as high as they can reach, and forest biodiversity and regeneration are adversely affected as a result. Heavy browsing by elk and deer are also cited as a major problem in aspen regeneration in the Rocky Mountains.



Heavy deer browsing, Allegheny National Forest.

In identifying these trends one should resist the temptation to think they occur separately in neat compartments. Where one trend is underway, another is likely at work. That interplay—combined with other forces that impact forest health—further complicates our discussion.

Fire and Forest Health

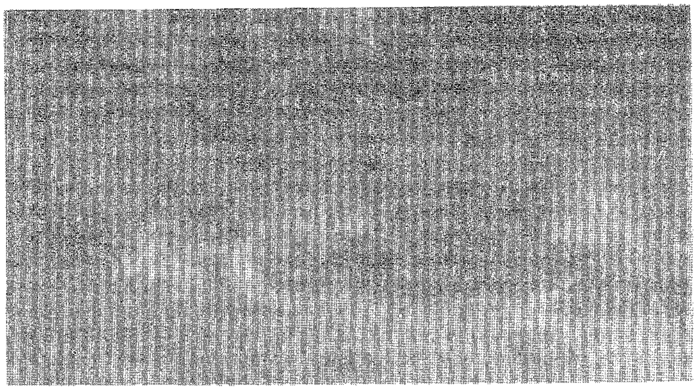
Virtually every forest type has experienced fire at some point, and many types evolved with fire as the major disturbance factor, affecting the forest's successional patterns and shaping its species composition (Agee 1993). Because of fire's importance in determining structural patterns in forests, and because people have so strongly altered the way fire operates in the forest, it merits a separate discussion as a major component of modern forest management.

The impacts of fire on the forest are very complex. Although there is much scientific literature about the effects of fire, and virtually everyone has an opinion as to what fire does in the forest, every fire is a unique event. Unlike some of the other natural forest disturbances—windstorms and flooding, for example—the behavior and ultimate effects of a particular fire are strongly influenced by the condition of the forest at the time of the fire. While a forest's condition may mean a different response to a windstorm, for example, the forest does not shape the windstorm itself. The forest's condition, however, dramatically shapes the fire. Thus, the manner in which a forest has been managed may largely determine the intensity and ultimate damage caused by a particular fire.

Fire is also an event that can be human-caused, in contrast to windstorms or (most) floods. People have used fire since precivilization to shape their environment, and the intentional use of fire has been a significant addition to the lightning-caused blazes that affected earlier forest development. Human fires also create different impacts and landscape patterns. Evidence suggests that Indians burned aspen groves early in the spring and late in the fall, for example, because that is when the leaves are off the trees and the ground fuels are dry. This created a very different impact than today's lightning-caused summer wildfires, which seldom burn far into the lush green aspen groves (Kay 1997).

A major change in fire conditions occurred with the advent of European settlement in the United States (Pyne 1982). Prior to that, American Indians used fire as their most powerful land management tool. Although popular myth often portrays the Indians as a limited population of nomadic people that did little to affect the environment around them, modern scholars are increasingly finding evidence of major populations that had extensive impact on the land. In addition to clearing land for agriculture, fire was used to favor plants desired for grazing or food; to reduce wildfire hazards around villages; to control dense vegetation, thereby eliminating cover for potential enemies; and to harass enemies during conflicts. Once ignited, a fire could burn for weeks or months under some conditions, because there were no efforts to suppress it.

With the arrival of European settlers and their wooden homes, fences, and towns, fire became a major threat and unwanted fires were extinguished wherever possible. In many areas, clearing or plowing land for agriculture fragmented the grass, brush, or forest areas that were previously free to burn when ignited. Livestock grazing removed many of the



Prescribed fire can mimic historic fires where fuels are similar.

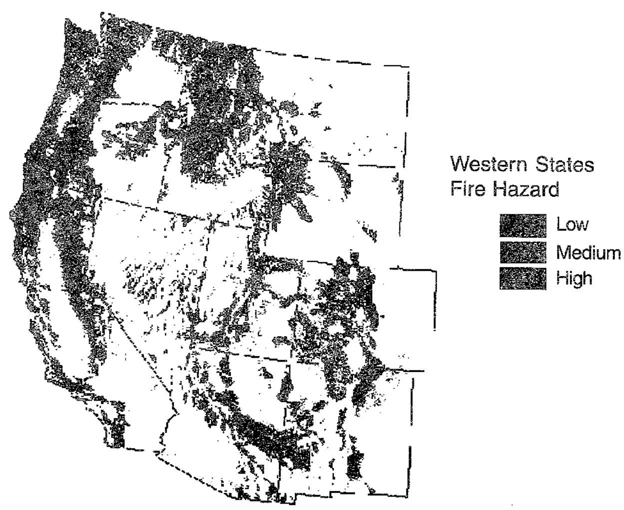
fine fuels (grass and herbs) that previously carried ground fires from place to place. Farmers, cowhands, and loggers—who saw in fire a force that destroyed resources they wished to use themselves—were quick to suppress any small fire they could control. As the federal government began to take more of a role in western land management around the beginning of the 20th Century, fire control was one of its primary missions.

Thus, in a matter of decades—an eye-blink of ecological time—many forests went from a regular fire regime to a nonfire regime. The ecological impacts were significant, and many are still not well documented by scientists. Some facts are generally agreed upon, however. Forests where regular ground fires kept brush and young trees in check began to change once fire was eliminated. Forests of massive, widely spaced oaks in the East, and pines in the South and West—the savanna structures—began to be filled in with species that could thrive in the shady conditions. As these newcomers grew larger and more competitive, the older trees often failed to survive. Forest diversity diminished as savannas gave way to dense forests.

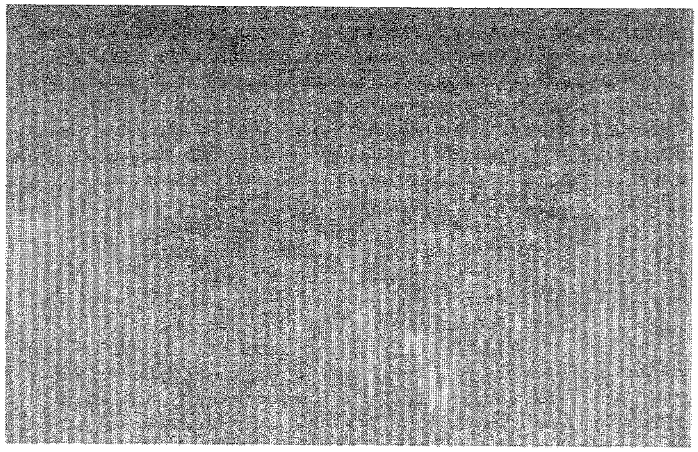
Open structures such as meadows and recovering burned areas diminished, as trees began to fill in the open spaces in the landscape. In some areas, the "edge" between forest and grassland began to shrink, as forests filled in the former open sites. Obviously, these changes affected wildlife habitat, as well as the cycling of rain, snow, groundwater, and nutrients.

Several studies of the current situation suggest that the forest types and structures that were most dependent on periodic fire (such as ponderosa pine savannas) are among the most heavily impacted by fire suppression. In addition, many of these types occupy low-lying landscape positions that were the most heavily impacted by land clearing, grazing, and timber harvest after settlement began (USDA 1996). A study in Colorado identified ponderosa pine, mixed conifer, and aspen forest types as those whose recent fire history is farthest away from the historical range identified by ecologists (Sampson et al. in press). The higher elevation forests in that study (lodgepole pine, spruce) were affected as well, but they were much closer to their past history. On the basis that these studies might be indicative of the wider region, the map (below) shows the general forest types in terms of the wildfire hazards that they face. This suggests that the more separated a system becomes from its historical fire regime, the greater the possibility of increased wildfire intensity and severity, which can translate into additional damage to the soil, as well as the forest biota.

In a frustrating paradox, our increasing human effectiveness at fire suppression itself has led to more devastating wildfires, because not only did forests change with the suppression of fire, but fire behavior itself changed as well (Covington and Moore 1994). Success in keeping fires out assured, in many situations, that the amount of available fuels increased. These fuels then feed the next, inevitable fire making it burn with additional heat and intensity. In forests where large trees historically survived the frequent, low-intensity ground fires, the modern fires burn at much higher temperatures, killing most or all of the trees, and affecting far larger areas. In the West, where large areas of wild lands and dry summer conditions lend themselves to significant wildfire events, the changes in vegetation support fires that modern technology is helpless to control. The average annual wildfire acreage in the 11 western states has increased significantly in recent decades, in spite of continued advances in sophisticated firefighting technology. Wildfire dynamics have changed, and the most likely reason is the changed vegetative condition of the forests, particularly the increase of dense forest structures caused by a combination of fire suppression and nonmanagement (Sampson 1997).



Virtually all western forests burn at some time. The degree of hazard reflects the risk of unusually hot fires that will damage soils or watersheds severely.

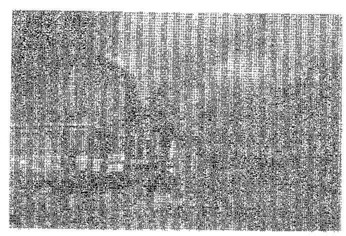


Lethal crown fires, once rare in ponderosa pine forests, are now common. Boise National Forest.

These wildfires come at enormous public expense. The Forest Service reported almost $1 billion in fire fighting outlays in 1994. The toll rises into billions of dollars for that one year alone when the costs incurred by other federal, state, and local agencies, as well as the resource damage suffered on public and private lands, are added.

The public attention spurred by the costs and losses involved in the recent wildfires has focused new federal studies and policies on the need to change forest management in light of the wildfire problem. The basic question for many land managers is "what should be done to alter forest vegetation so that future fires will be less intense and destructive?" A recent policy study by the federal government says that the best approach is to use fire to fight fire through a major increase in managed fires (usually called prescribed, since they are allowed to burn as long as the weather and fuel conditions remain within "prescribed" limits) that reduce the fuels and lower the damage potential for future wildfires (USDI/USDA 1996).

But it may be easier to adopt such a policy statement than to apply it on the land. A century or more of fire suppression has allowed conditions to change so dramatically, over such large areas, that simply reintroducing fire into the current situation is to invite disaster. Before fire can be safely



Protecting rural homes from wildfire is costly and dangerous for firefighters. Boise National Forest.

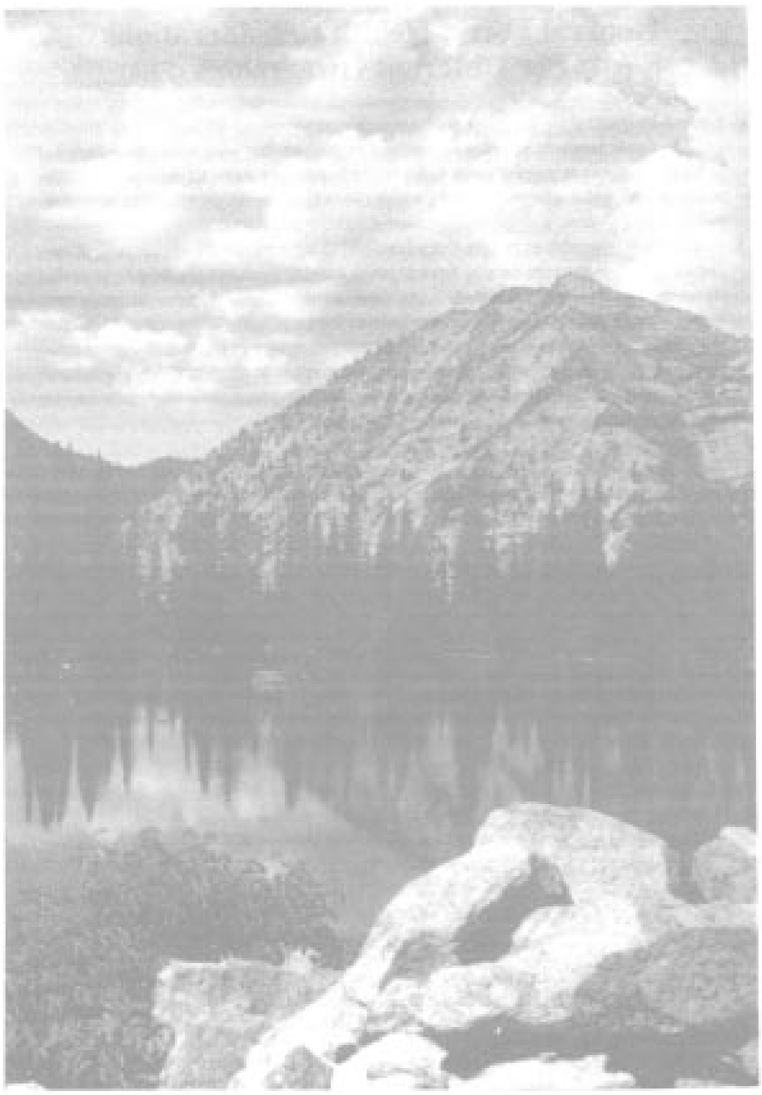
used in many places, excessive fuels must be removed so that the fire will burn at lower heat and intensity, and with less destructive impact. In many places, that means a significant investment and effort to restore conditions that are less subject to the kind of intense wildfires that do more harm than good.

Public forest managers, hit with the double whammy of an enormous amount of land to manage and cutbacks in state and federal budgets, face a daunting challenge. In addition, they face groups of skeptics who consider forest health treatment a thin veil for simply increasing old-style timber harvests to satisfy economic interests. For private land managers, the risks and costs involved with managing fire safely in an environment sprinkled with houses and other ownerships, as well as the regulations designed to reduce smoke pollution, combine to make fire a problematic management tool. In the southern states, where prescribed fire has long been a staple of forest management practice, growing populations and opposition to smoke pollution have led to public controversy.

In many areas, the fragmentation of private forest land into small tracts and homesites has created a complex intermix of ex-urban growth and wildland that makes fire too risky for most owners to tolerate, let alone use on purpose as a management tool. In these areas, returning the ecological effects of fire to the forest is a problem that, to date, has not yielded a satisfactory answer. Such processes as nutrient and carbon recycling, or the heat pulse that helps some plants germinate, are not easy to replicate. If these ecological processes prove, over time, to be critical to the forest's future, managers and researchers are challenged to find substitute methods of producing them.

There are other technical problems as well. After a forest has missed several fire cycles, the changes in vegetation may make it enormously difficult to reintroduce fire safely. In the ponderosa pine forests of the West, large pine trees that have survived dozens of fires prior to the last wildfire (which usually happened in the late 19th or early 20th Century), are now extremely vulnerable to fire. Large piles of dead needles and bark flakes have built up around their bases, and small roots have grown into the litter on the forest floor in search of water and nutrients. Where that has happened, even a well-controlled fire can do lethal damage. Since a fire-damaged tree may take months or years following the fire to die, it is difficult to know when a prescribed fire is doing its intended job or is killing the trees that the manager is trying to save. Similar challenges exist for people wishing to reintroduce fire safely in forests containing giant sequoia, oak, or other species that were fire-tolerant under the historical fuel and fire conditions.

In short, the reintroduction of fire as a regular disturbance in forests creates enormous challenges for land managers. Research is underway, but may take years to produce definite results. Forests that have been without fire for decades are seriously altered and, in terms of our forest health definition—unhealthy. Their present condition also means that they are unstable and at high risk of experiencing major damage in the next few years. The fact that the forests took decades to develop this unstable condition does not suggest that they can remain unstable for an equally long time, and to delay treatment is to invite damage. Restoring healthy conditions normally requires either restoring fire as a regular process or carrying out other silvicultural operations such as thinning and timber harvest in ways that mimic fire's effects. Neither is easy, and forest scientists and managers are challenged to find ways that are acceptable under 21st Century land use and environmental conditions—and which today's citizens will support.

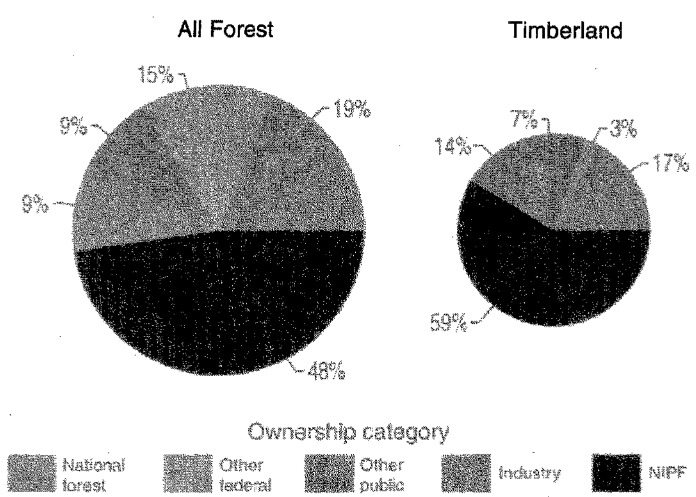


General Forest Health Considerations For Different Ownerships

Forest Industry

The forest products industry (defined as companies that own both forest land and industrial facilities to process wood or paper products) owns about 10 percent (71 million acres) of the Nation's forests, most of which (70 million acres) are classified as timberlands.

Industrial ownerships are generally managed in large blocks for the purpose of producing wood for products ranging from paper to housing materials. As long as favorable economic and regulatory conditions exist, these owners are motivated to maintain their forests in good growing condition. Large industrial owners have the capacity and funding to incorporate the latest in scientific findings and technology (which small owners often lack) and the freedom of action to test new and innovative ideas (which public managers almost always lack). They tend to resist pressure to fragment their lands into smaller ownerships.



Ownership of United States forest and timber land. The U.S. has about 738 million acres of forest land. About 490 million acres are suited and available for growing timber crops.

Through their major U.S. trade association—the American Forest and Paper Association (AF&PA)—the industry has created the Sustainable Forestry Initiative (SFI), which requires all association members to follow a set of principles and guidelines designed to achieve sustainable forestry. The goal is to improve the management of industry-owned land to achieve sustainable conditions recognizing the value of clean air and water, productive soils, diverse fish and wildlife habitat, and pleasing aesthetic conditions. Progress in implementing the SFI, which has been in operation since 1995, is the topic of an annual report to the public that invites public scrutiny of the industry's practices.

From a forest health standpoint, industrial forests are generally maintained in young to mid-aged stand structures. Industrial forests based on plantation management lack the species diversity and habitats associated with older, more complex forest structures, but this is offset in some areas by increasing protection of streamside management zones that break up plantations and allow development of older, more complex areas that provide habitat diversity. Since young forests are less likely to experience some of the stress-related disturbances like insect epidemics, and since their owners tend to manage intensively to avoid damaging epidemics or disturbances, these forests are often found in excellent condition. Industry's forests are clearly at the mercy of economic forces, however. If a corporate takeover or other decision is followed by an "asset liquidation" that strips the merchantable timber, years of sustainable forest management can be quickly lost. Thus, from a forest health point of view, maintaining long-term ownership stability and commitment to sustainable forestry practices is a major benefit.

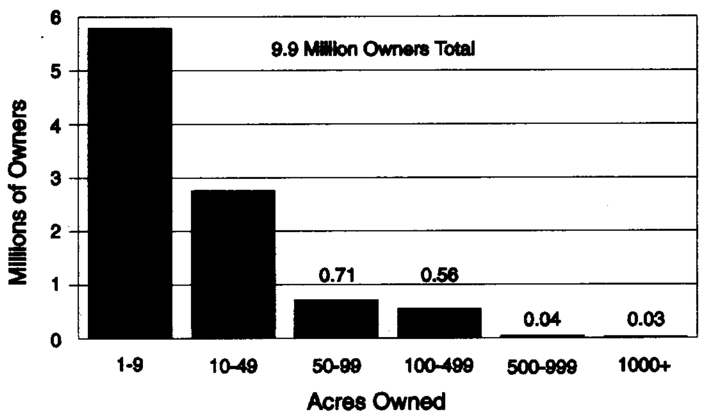
Nonindustrial Private Forest (NIPF) Owners

NIPF owners control about 48 percent (353 million acres) of the Nation's forests, of which 288 million acres are classified as timberlands.

Individuals and families own most of the nonindustrial private forest lands, although there are some large blocks held by family trusts, investment interests, American Indian tribes, and Alaskan Native Corporations. NIPF areas are more subject to fragmentation pressures than industry lands—trends show continuing declines in the mid-sized ownerships, accompanied by increases in the number of owners. In general the large ownerships use professional advice in managing their forests and the smaller ownerships do not. As ownerships become smaller, less of the land is managed with the assistance of modern forestry expertise. Fragmentation also means that these forests are less likely to function as large-scale ecosystems, and forestry practices such as prescribed fire, thinning, or timber harvest become difficult to plan and apply. Most of the eastern forests are in this ownership category.

There is a tremendous diversity of forest stages and conditions on NIPF lands. Since they often occupy some of the gentler terrain and most productive soils in a region, they tend to be some of the most resilient and productive biological systems. Many owners live on or near their properties, allowing for close and personal involvement in forest care. Where family and personal ownership pride and economic opportunities exist, some of the Nation's finest forest care takes place on such lands.

Timber is harvested from almost all NIPF lands at some time, but often without benefit of a plan or professional advice before, during, or after harvest. Annual property



Private forest ownership by size of ownership. Source: Birch 1995.

taxes, complex income tax rules, and estate taxes exact a constant toll, pushing these forests toward smaller sizes, premature or ill-planned harvests, and conversion to other land uses.

The result of these forces are portrayed in the disturbing trends in today's NIPF ownership patterns (Sampson and DeCoster 1997). The rapid rise of ownerships smaller than 100 acres leads to the conclusion that, by 2010, over 150 million acres—38 percent of the Nation's most productive forest lands—could be held in ownerships less than 100 acres in size. Many of these owners are older and retired, suggesting a continued high turnover and fragmentation rate. When older owners die, the pressure of estate taxes can force heirs to liquidate timber or sell the land in order to pay taxes. Even where that isn't the case, the children have often moved far from the land and have little interest or ability in maintaining the forest management plans that have been in effect. Forests live longer than people, and generational change—which is seldom a problem on public or industrial lands—can have significant impacts on NIPF quality.

Federal Ownerships

The federal government controls about 34 percent (249 million acres) of the Nation's forests, of which 97 million acres is classified as timberlands while over 152 million acres are legally set aside for other uses such as wilderness or parks, or do not produce enough timber to warrant commercial management.

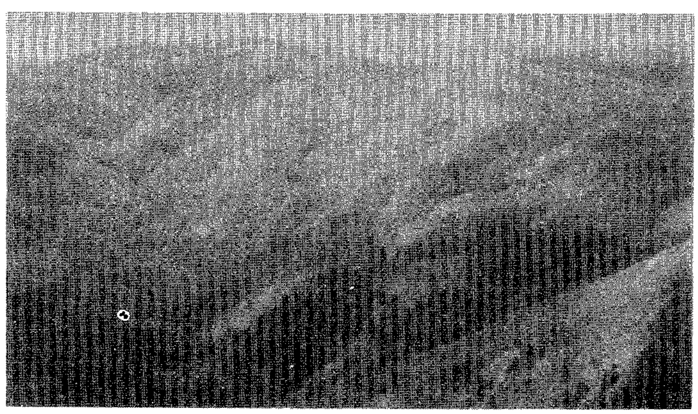
Federal forest lands were acquired to protect large blocks of resources for public benefits ranging from recreation to watershed protection; wildlife habitat to wood supply.

Forest managers have done that for the most part in a context of increasing tension between local and national interests, and between economic and environmental users.

These lands provide large natural areas protected by federal authority, which resists the economic and development pressures that fragment and convert private forests to small chunks or other uses. A complex and often conflicting web of laws, combined with cuts in budget and staff, has taken its toll on the management of these forests. Conflicts over these lands and their use have become more complicated, and there has been a growing public attitude that these lands should be left to nature and not managed or affected by human activity.

Public management of large areas facilitates big solutions to big problems where people can agree; it also affords an opportunity for profound gridlock when people don't agree. The nature of big solutions is that they are hard and often slow to implement, meaning situations can develop into a big-mistakes-followed-by-big-correction scenarios common in large centralized systems. It is easy for national political debates (often framed in polar arguments) to lead toward one-size-fits-all policies or programs that may have little to do with local conditions.

The bulk of the revenues from timber sales, grazing, and mineral leasing go into federal accounts rather than into local land management. A share goes to local government to support roads and schools, while the local economy also profits from the jobs and economic activity created by federal activities. Land management budgets for the federal agencies are developed within the federal budget and appropriations process. Because bringing money into local communities and the federal coffers is always a more attractive political priority than spending appropriated funds, Congress has been more likely to favor practices that produce revenues than in authorizing budgets to carry out forest maintenance.



Insect epidemics are a problem in large areas of uniform forest conditions and structures.

The controversies over federal forest management, most of which are not directly due to forest health concerns but which nonetheless affect forest conditions, are leading toward new approaches. Ecosystem management, with its emphasis on site conditions and adaptive management, has become accepted federal land management policy, but is increasingly shown to be inconsistent with single-dimension federal policy decisions or the relatively inflexible forest plans developed under 1970s-era policies. Policy gridlock driven by polar constituencies has become frustrating to most of the participants, driving interest in seeking new ways to resolve difficult issues.

Included in the new approaches are community-based "collaborative" groups that focus on a particular piece of public forest, and bring together as many interests as possible to work out agreement on what kinds of action would be in the interests of the entire community—people and forests combined. While those approaches are new, and not yet fully supported by federal legislation, the appeal for decentralizing decisions and creating a better connection between local conditions and federal policies seems strong. Another approach, still to be tested, would involve state forestry agencies in the role of "management agent" for the federal government, particularly in areas where federal, state, and private lands are intermingled with ex-urban growth, creating a complex intermix that is, in many cases, the most dangerous and difficult wildfire situation faced by forest managers today.

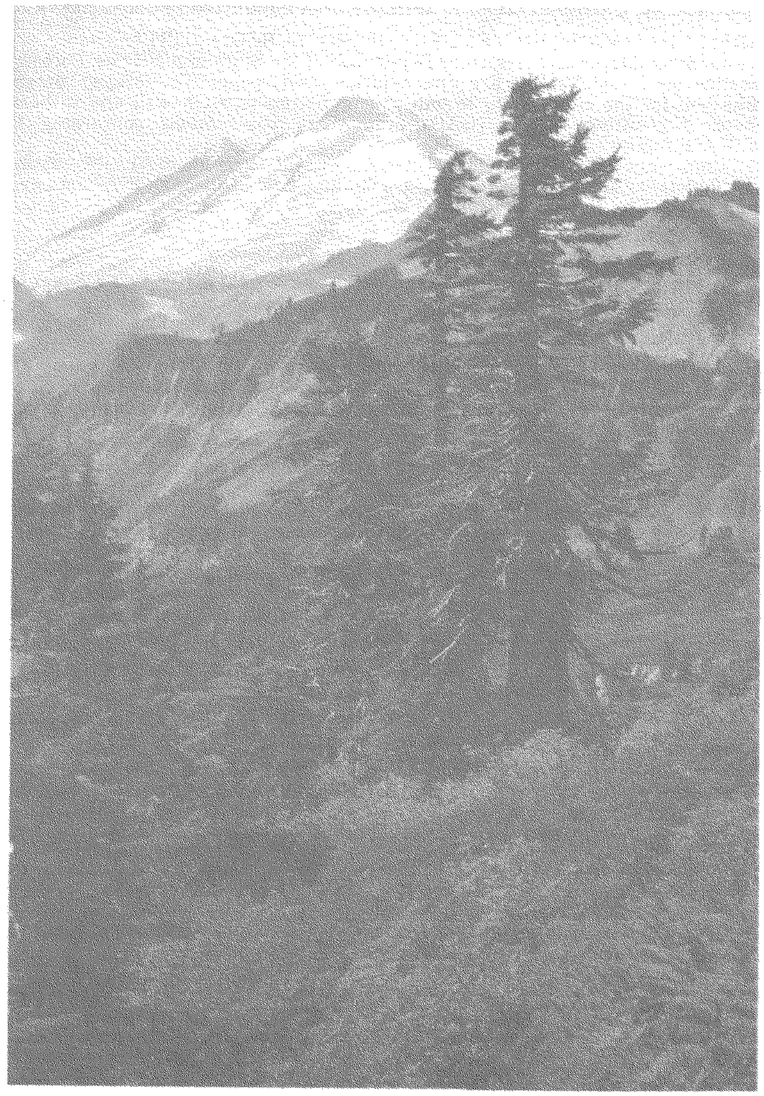
Other Public Ownerships

States and local governments control about nine percent (65 million acres) of the Nation's forests, of which around 35 million acres are classified as timberland and around 30 million acres are in parks and other reserves.

State and local governments can respond more directly to local concerns than federal managers, but many of the problems such as inadequate staffing and restricted budgets are similar to those on federal lands. State forests in western states are often found in isolated sections that were granted at statehood, and these are sometimes hard to manage because of their intermixture with other ownerships. Public forests protect large areas from the tax and development pressures that might otherwise fragment them. In some areas of the upper Midwest and Northeast, state forests may be more important in maintaining large forest areas than either the federal government or private industry.

There is strong staff capability at the state and local level to apply professional expertise to their land management, and this may often affect large areas. The land can be held long-term and managed for noneconomic outcomes and public uses. Big solutions to big problems are possible (if people can agree on both the problems and the solutions), and there is access to tax dollars for maintenance of public resources.

Although state and local decisions may still be politicized, they are in closer context with local conditions than are many federal decisions. In many states, the manner in which the state forests are handled is established by the state's constitution, or in fairly rigid state law. Thus, one state may have to manage their forests for maximum return to the state's educational budget, while another may be dedicated to keeping large areas of forests "forever wild," and allowing no harvest of any kind.



STATEMENT OF JANICE MCDOUGLE, ASSOCIATE DEPUTY CHIEF, STATE AND PRIVATE FORESTRY, UNITED STATES DEPARTMENT OF AGRICULTURE, FOREST SERVICE

MADAM CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

I am Janice McDougle, Associate Deputy Chief for State and Private Forestry responsible for forest health, fire and aviation, and cooperative forestry programs. Thank you for the opportunity to join you to discuss forest health and to hear the General Accounting Office's (GAO) preliminary observations concerning forest health and fuels.

It is our understanding that the GAO report will focus on the health of the nation's forests as it relates to fuel conditions and risk of damage from catastrophic wildland fire. The Forest Service is looking forward to working with GAO to identify ways to continually improve forest health conditions.

Wildland Conditions—What is the Nature of the Problem?

We estimate that approximately 39 million acres of National Forest System lands, primarily in the inland West and the Atlantic coastal states, are at high risk from damaging, high-intensity, wildland fire. Many of these stands are dense and overcrowded with high mortality rates due to bark beetle or other insect outbreaks. For instance, in eastern Oregon and Washington, forest inventories show that mortality has been above average over the past decade on all forest ownerships.

It is important that the public understands that fire is part of a natural, ecological cycle and, over a long enough period, all forests will eventually burn. The exclusion of wildland fire for the last 100 years has had a profound influence on the composition and structure of natural fuel conditions, and the function of those ecosystems where frequent and low-intensity fires historically occurred. These conditions are contributing to the growing severity of the fire situation throughout the country. Unless we address these changed conditions, the fire severity situation will continue to grow, threatening the health of watersheds and larger ecosystems.

In addition to changes in natural hazardous fuels, demographic changes of people moving from urban areas to rural areas have resulted in an increasingly complex mix of people, infrastructure and forests, which is known as the wildland urban interface. Throughout the United States it is more and more common to see homes and other types of structures being built in wildland environments. Because of their location, these structures are extremely vulnerable to fire should a wildland fire occur in the surrounding area. This trend is resulting in a volatile situation that must be addressed.

Management Direction—What are We Doing?

This is as much a forest health concern as a fuels condition. We are addressing this problem at the most fundamental level. We have embarked on an aggressive program to use fire in a more natural ecological role to reduce hazardous fuels and to help protect forest ecosystems from the ravages of high-intensity fires and epidemic insect attacks. Other tools we are using to improve ecosystem conditions include timber sales, thinning, and other fuel reduction methods, including mechanical treatments. However, we will not treat, nor is it practical to treat, all of the affected acreage. Therefore, we are prioritizing the areas to be treated first, to address those areas of greatest risk and potential for damage such as, wildland urban interface areas, critical watersheds, and sensitive wildlife habitats. This strategy will focus available funds and capabilities where they will have the most effect. We are creating a management environment that encourages the treatment of those priority areas through budget allocation and direction to local managers.

To help better understand the nature of the issues, we are currently implementing the Joint Fire Science Plan as provided in the Conference Committee report for the 1998 Interior Appropriations Act. The four principal purposes of the plan are to complete a national program for:

- Fuels Inventory and Mapping
- Evaluation of Fuels Treatment
- Scheduling of Treatments
- Monitoring and Evaluation

Projects have already been identified and grants and contracts issued to help us better manage the hazardous fuel reduction program.

We appreciate Congressional support for expanding our fuels treatment program. During FY 1998, the Forest Service will have treated more than 1.2 million acres. By 2005, we plan to treat at least 3.0 million acres annually. Treatments will continue to focus on high hazard areas and those which pose significant risk to highly valued resources, public and firefighter safety and wildland urban interface areas.

This program expansion has received Congressional support both in terms of increased appropriations and a budget structure that moved hazardous fuel reduction activities from Preparedness and Fire Use to Fire Operations. This allows flexibility in funding hazardous fuel activities to address more effectively the health of NFS lands without detracting from the capability to prevent forest fires and take prompt action on supressing wildfires. The Federal Fire Policy, also, has given both the Forest Service and the Department of the Interior greater flexibility to manage wildland fire to benefit resources, particularly using prescribed fire.

Management Needs—Challenges

As the hazard fuels reduction program expands, we are facing many challenges that may reduce our ability to use cost effective prescribed fire. Examples of these challenges include public acceptance and understanding of prescribed fire practices, smoke management issues, and concerns for homes and structures in the wildland urban interface. Also, costs to treat the highest priority areas, such as highly valued resource areas and wildland urban interface zones, will be higher than current national fuel treatment costs per acre. This is because some of these areas will require multiple treatments, such as combinations of mechanical treatments and fire to be safely and effectively executed. Other internal challenges to accomplishment of hazard fuel reduction goals include maintenance and development of skills, training, personnel and contracting authorities to support adequately the program.

Summary

Clearly, the challenges we face in improving forest health and reducing fire risk are great. By restoring fire to its natural role in ecosystems, we can improve the health of our nation's forests while, at the same time, reducing their susceptibility to catastrophic fire. Through improved collaboration among cooperating Federal agencies and State and local entities we can maximize the effectiveness and efficiency of our fuels treatment and fire fighting efforts insuring that resources are better utilized.

We cannot lose sight of the fact that the current situation developed over many decades. Any solution requires significant time and commitment. The Chief is changing accountability within the agency to assure that the performance measures of District Rangers and Forest Supervisors are directly related to the conditions of the forests they manage. We are working to assure that there is a comprehensive inventory of conditions and strategic "plan of attack," and we are working to insure that all stakeholders are partners in our efforts. We believe that we have the ability and capability to move towards improved forest health and reduced fire risk in critical areas of concern to the public.

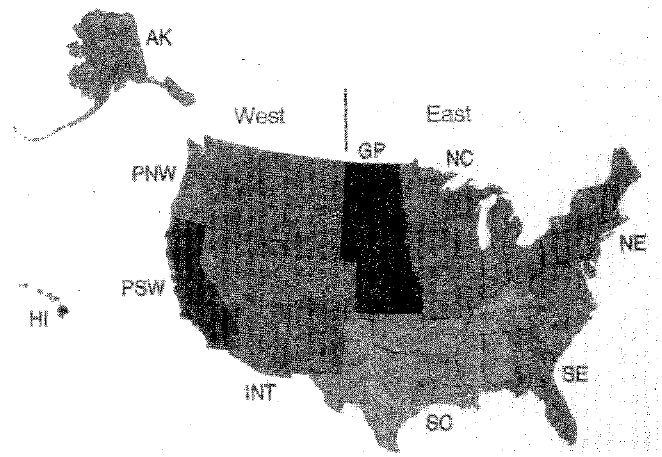
Thank you, Madam Chairman, and I welcome any questions the Subcommittee may have.

Differences in East and West Forests

Many of the major trends identified earlier affect forest health in every region of the U.S., but their relative importance is significantly different. Dominant forest types, environmental conditions, patterns of human population, and forest ownerships are very different between forests in the East and forests in the West. The varied relationships between people and forests affect how and why forests are owned, the capabilities and expertise applied to forests, and the decision-making processes for responding to forest problems.

A comparison of the two regions reveals that:

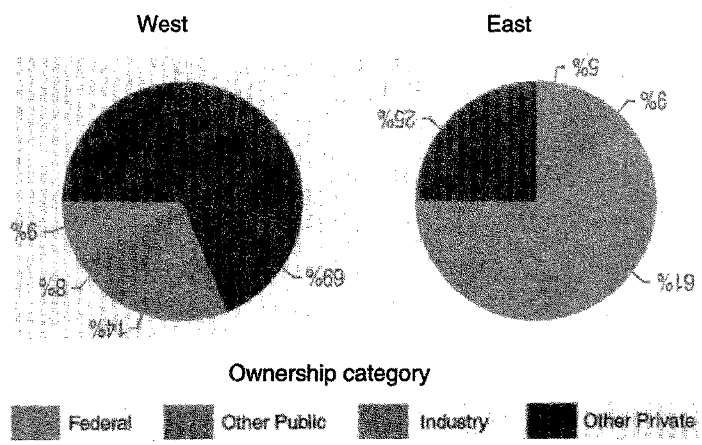
- The East and West are well matched in forest area (52 percent in the East; 48 percent in the West).
- Concentrations of people are vastly different. About 78 percent of Americans live in the East, fairly well spread across the landscape. Of the 22 percent who live in the West, more than half live in California and the remainder are found mainly in a few large cities.



Forest data is commonly presented by regions (AK - Alaska; PNW - Pacific Northwest; PSW - Pacific Southwest; INT - Intermountain; GP - Great Plains; NC - North Central; SC - South Central; NE - Northeast; SE - Southeast).

- There are 187 acres per 100 people in the East; 623 acres of forests per 100 people in the West.
- Federal ownerships dominate the West—more than 60 percent of all western forests are federally owned.
- Private ownerships dominate the East—69 percent of all eastern forests are in nonindustrial private (NIPF) ownership.
- More than 80 percent of all federal lands in the U.S. are in the West; almost 80 percent of all the industrial and other private forests are in the East.
- If we recognize that a major value in public forests is providing public recreation, there is almost a ten-fold disparity between East and West, with the West (excluding Alaska and Hawaii) having 265 acres of public forest per 100 people, while the East has 32 acres of public forest per 100 people.
- Private timberland, on the other hand, is twice as available in the East (136 acres per 100 people, compared to 76 in the West; see Table A.2, p. 71).

These profound differences make it difficult to develop over-arching national policies and programs aimed at forests and forest health. As Table 1 illustrates, a national discussion of just one of the major trends affecting forest health (e.g., fire) cannot be conducted without the debate taking on almost entirely a regional flavor. The fact that wildfire affects federal lands and budgets so importantly makes it a political issue for the federal government, but it will not be seen as very important by people whose interests lie mainly in the East. The ranking of the relative levels of importance are subjective, and may not reflect a particular local situation, but illustrate some of the differences involved.



Federal ownership dominates western forests, while in the East, nonindustrial private forests are the most common.

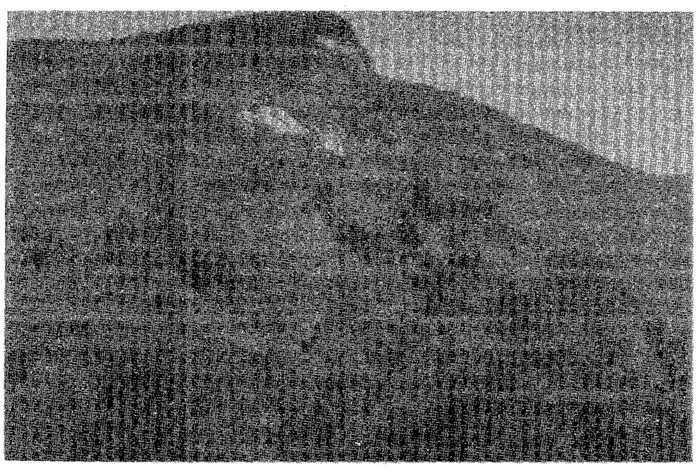
Table 1. Relative Level of Importance of Broad Trends Affecting Forest Health, By Region

Region	*Low* ← ←		*Level of Importance* → →		*High*	
East	Simplification	Fire	Animals	Fragmentation	Exotics	Emissions
West	Emissions	Fragmentation	Animals	Exotics	Simplification	Fire

Eastern Forests

Millions of private decisions, complex market forces, and more than 205 million people living among 384.5 million acres of forests combine to determine forest conditions in the East. Exotic plants, animals, and pests spread rapidly into native forests here.

Forest air, water, and soil are impacted by emissions from population and industrial centers, with some eastern forests receiving up to 15–20 times more nitrogen than western forests. This has been the focus of a great deal of study as to the effects of "acid rain," but research results on the effects of acid rain alone have generally failed to show it as a direct cause of tree death. The subject of airborne pollutants is a lot more complex than simply acid rain, and the effects of these chemical inputs to the forest have proven very difficult to document in most cases. Localized impacts have been demonstrated, but widespread regional or national effects have not. Ask a forest ecologist, however, whether or not a major change in a primary nutrient is likely to have an unbalancing effect on an ecosystem, and the response is that it will.



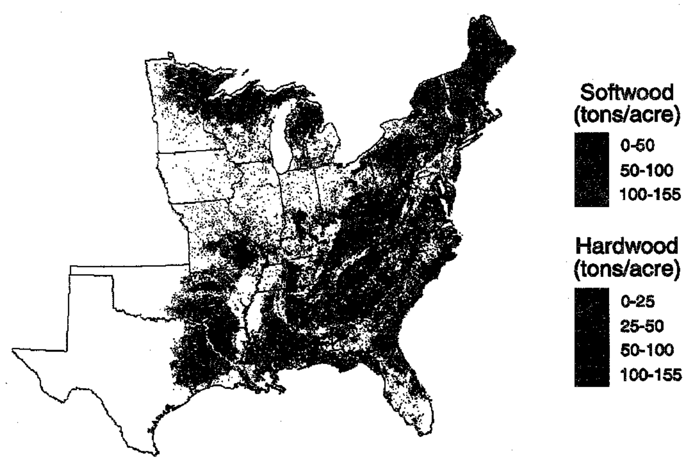
Fall colors attract thousands of visitors to northeastern forests each year.

There is tremendous pressure toward fragmenting the eastern private forests into smaller tracts as people seek rural lifestyles. Large blocks of public land and industrial land are under pressure to serve recreation needs and nature-preserve priorities. Part of serving those needs is, of course, reducing visible signs of forest management.

These forests constitute much of the Nation's sustainable supply of wood for products. Most of the lands available and capable of sustaining both wood supply and environmental functions are in the East—80 percent of the forest industry lands and almost 80% of the nonindustrial private forest (NIPF) lands. Stated another way, of the 490 million acres classified as productive timberland (land capable of producing 20 cubic feet or more of wood per acre per year and not dedicated to other uses) in the United States, almost 361 million acres (74 percent) are in the East (Table A.2, p. 71–73).

Many eastern forest regions are dominated by mid-aged forest stands and structures—the result of shifts away from centuries-old patterns in logging, agriculture, and settlement. This may produce forests that look thrifty and healthy at the moment, but which lack the diversity of stand structures needed to support historical biological diversity in the region. In particular, there is a lack of the savanna structures and the complex (often called "old-growth") structures, replaced instead by widespread areas of dense structure.

Species shifts are evident. Major species such as chestnut are gone, and oak is being replaced by shade-tolerant species such as maple. The result is a forest that is not, in many places, similar in composition or structure to the historical forests that developed on these sites. The present-day hardwood forests—regrown following cultivation in the early 20th Century or heavy logging in the late 19th Century—are relatively even-aged over fairly



A study by Sandra Brown and associates gives a good indication of the forest biomass densities across the eastern forests.

large areas. They are heavily intermixed with people, roads, and communities. Active forest management and activities such as logging have been limited as the forests were regrowing, but could become more common—and more controversial—if future market conditions favor more active logging.

Forest health questions, which have been largely concerned with epidemic outbreaks of pests such as gypsy moth and bark beetles, seem certain to become more complex in the future. As dense forests grow older, and trees become larger, more crowded, and competitive, will we see stress-induced pest epidemics, large-area die-off, or wildfire problems similar to those that are already evident in other regions? In many cases, we do not know. It is not a possibility that should be ruled out, however, because if it occurs in combination with public pressures opposing active management intervention, the result could be major—and potentially destructive—change over large areas inhabited by millions of people.

The challenge, as these forests become older and less stable, will be to introduce needed management without repeating the widespread forest removal that characterized the earlier logging eras. Efforts such as the forest products industry's Sustainable Forestry Initiative (SFI), and the forest certification programs currently being developed by organizations such as the Forest Stewardship Council, may help create the credibility and public support that will be required to address future forest health problems.

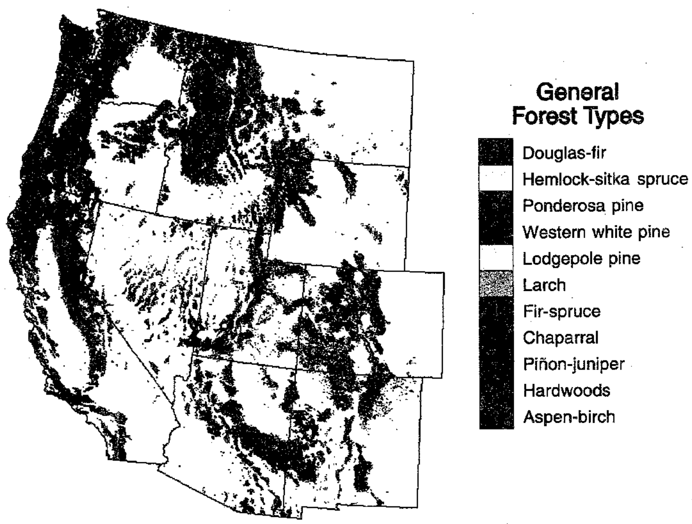
Western Forests

The dominance of government-owned forests in the West creates special conditions. The West has a little more than 58 million people, living primarily in a few concentrated areas—56 percent in California alone. Most of the 363 million acres of western forests are held in large blocks of federal ownership, and most of the other forest areas—held privately or by states—are also in large blocks. State forest practice acts are in place in many western states, providing regulatory controls on private forest management. The tendencies toward centralized regulatory control contributes to large areas with uniform conditions. Large expanses may be cut rapidly, or have no cutting at all; they may be dominated by uniform stands of very old forests, or very young. Recent endangered species regulations requiring management of some areas devoted to the needs of one species are creating additional uniformity.

Fire suppression activities since settlement have reduced the diversity created by presettlement fire patterns. Structural diversity has been lost even in remote wilderness areas, as airborne fire fighting capability suppressed many of the smaller fires that would have created "patchiness" in the landscape, and the late fall and early spring burns ignited by Native Indians were eliminated.

Available timberland is fairly rare in the West. Although the West contains half of the Nation's total forests, it has only 27 percent (129 million acres) of the available timberland. Two-thirds of those timberlands (80 million acres) are on public lands, making public land policy a major economic issue with western communities, and important in terms of the national timber economy, as well.

Uniform management of large areas increases the risk that a major disturbance can rapidly cause widespread changes in the landscape. These disturbances include massive



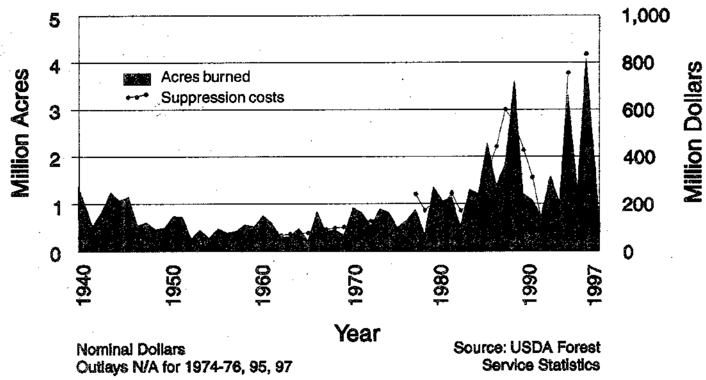
Western forests occupy mountain ranges and wetter regions. Many of them exist at the edge of deserts too dry or alpine regions too cold for trees to survive.

die-offs from insects, diseases, and other agents, and wildfires that are far larger, more intense, and more environmentally destructive than those that historically disturbed the forests.

Federal managers trying to respond to these conditions are torn by incompatible goals, differing interest group pressures, and conflicting federal legislation. Recent government downsizing has reduced budgets and staffing assigned to maintain public forests while costs of catastrophic events are rising. The U.S. Forest Service spent nearly $4 billion on forest fire control from 1985–1994, as large fires swept through fuel-heavy western forests. The visible results of that expenditure were around 18 million acres of burned-over landscapes, many of which will take a century or more to return to their pre-fire condition.

The total cost—fire fighting expenditures, lost lives, property and resource damage, and the energy and money devoted to political battles over what to do with fire-damaged timber—runs into uncounted billions of dollars. Measurable social and environmental benefits of the experience are few, while institutions and civil discourse suffer greatly from the political controversies stemming from such legislation as the 1995 "salvage rider" (see page 38).

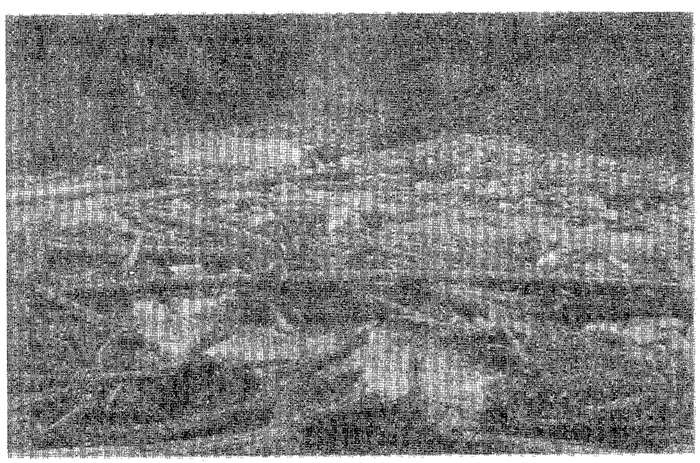
On balance, the current wildfire situation argues for a new approach to public land management, but the issues—fire ecology, risk assessment, prescribed fire and smoke, impacts of mechanical treatment—are both complex and, in today's world, controversial. The need for increased public dialogue and agreement is clear, as is the need to reach



Wildfire acres burned and fire suppression costs (U.S. Forest Service in 11 Western states, 1940–1997).

agreement quickly as forests continue to face additional damages. In places like the Boise National Forest of Idaho, where around one-third of the ponderosa pine forest has been burned since 1989, time is quickly slipping away.

Forest health conditions in other forest ownerships in the West are deeply affected by the over-arching federal ownerships. Forest traumas don't stop at boundary lines, and



A modest summer rain on wildfire-damaged soils (see p. 63) resulted in a major debris- and mud-flow that damaged the North Fork of the Boise River in 1995.

insect and disease infestation, exotic species invasions, fires, and other problems tend to move freely from one ownership to another. Because federal lands are often in more remote, high-elevation locations, the changes that occur in them may flow downhill to affect lands and waters below. Conversely, the people and animals from the populated areas may create unusual impacts or import exotic species into areas that would otherwise seldom be impacted.

Private decision making and economics are also affected by the federal presence. Development pressures may be concentrated into very small private areas near public forests, and local or regional timber markets can be disrupted as federal timber goes on and off the market due to political decisions made in Washington.

The 1995 Salvage Rider

In 1994, wildfires burned 4 million acres, mostly on federal land in the West, and the Forest Service spent over $1 billion for fire fighting. The smoke still hung in western valleys as the fight heated up over what to do with the fire-killed timber. At the time, the Forest Service estimated that there were some 18 billion board feet of fire- and insect-killed timber on the National Forests, of which 4–5 billion board feet could be salvaged economically without damaging the environment. In general, the dead timber had to be harvested within two or three years, before it lost economic value to decay and insect damage.

In Congress, legislation was introduced to expedite timber salvage on federal lands by exempting salvage sales from administrative appeals, limiting the time available for judicial review, and easing environmental planning procedures. The legislation was attached as an amendment to a rescissions bill for the fiscal year 1995 budget, thus the name "salvage rider." President Bill Clinton vetoed the bill, citing opposition to several nonforest provisions, as well as criticizing the salvage rider. Congress and the President worked out compromises on the other issues, and the President signed the bill (P.L. 104-19) on July 27, 1995. The salvage rider established the expedited program through December 31, 1996.

Implementation of the bill was immediately surrounded by controversy. Environmental organizations labeled it "logging without laws," a charge contested by the Administration, who directed the agencies to salvage the timber under existing environmental laws. As implementation proceeded, the Forest Service found itself in court battling with both the forest products industry, who claimed the agency was not following the law effectively, and the environmental organizations, who claimed the law was being extended beyond its intent.

One particular area of controversy had little or nothing to do with dead timber. One section of the rider ordered the release of green timber sales that had been halted because of concerns for environmental issues. Those sales had been directed by section 318 of the 1990 Appropriations Act. They had been prepared for sale, but withdrawn by the agencies because of environmental concerns. Many of them were "old growth" forests, increasingly prized as wildlife habitat and ecological reserves, and the environmental opposition to their harvest was intense.

For many in the forest conservation community, the salvage rider was a nonevent until the section 318 sales were added in the Senate version of the bill. For the most part, all of the salvage sales that could be done in the 18-month period were well into the process of environmental assessment, and most of the decisions had been made. But the section 318 sales set off a storm of opposition that overwhelmed virtually any assessment of the salvage rider's environmental impact.

The General Accounting Office reviewed the salvage sales conducted under the rider, and its 1997 report noted that several of the salvage rider's features, such as expedited reviews, seemed to have caused little impact in terms of either the amount of timber harvested or the harvest methods used. They also reviewed 14 salvage sales that had been challenged by environmental organizations on the grounds that they contained too many green trees to qualify as "salvage," and found that the Forest Service had adequately documented its reasons for including these sales under the salvage rider definitions.

For all these studies and opinions, however, one fact remains clear. The 1995 salvage rider poisoned relations between the Forest Service, the forest products industry, and the environmental community. Any future attempt to expedite forest health treatment on the National Forests, regardless of its scientific basis, will have to withstand the challenge that it is not "just another salvage rider."

economic opportunity to do thinning, because the trees that need to be removed are the smaller, less valuable ones that do not pay for the work involved. Unless the owners are willing to invest for long-term values in these stands, they may stay in this condition until fire, wind, or pests disturb them.

- Reproduction and survival of new plants may be largely limited to shade-tolerant species in a dense forest. Thus, as the larger, more dominant trees die for various reasons, they are replaced by the shade-tolerant species that have grown in under them. Such transitions move pine forests toward fir or hardwoods, coastal Douglas-fir toward hemlock, oak toward maple. Where these transitions reduce forest values that people feel are important, or set the forest up for new kinds of disturbances that people feel are damaging, intentional management of the trees may be the only way the transition can be halted.

Table 2. Western Forest Health Concerns

Forest Type	*Primary Region**	*Health Concerns*
Spruce	Alaska	Large uniform areas of dense, mature stands with insect epidemics and major wildfire risk
Douglas-fir (coastal)	PNW (west side)	Concerns with retention of complex stands and excess fragmentation on low-elevation lands. Major windstorms can create large areas of dead & down trees, followed by large, hot fires. Endangered species include northern spotted owl, several species of salmon and trout.
Douglas-fir (inland)	PNW (inland); Inland West	Invades ponderosa pine and western white pine sites when fires are suppressed. Dense, stressed stands encourage root rot and mistletoe, setting the stage for large, lethal crown fires.
Ponderosa pine	PNW (inland); Inland West	Savanna structures severely lacking; large areas of dense and understory stands exhibit stress, particularly during droughts. Wildfires burn as lethal crown fires instead of nonlethal ground fires due to ladder fuels that carry ground fires into treetops.
Mixed conifers	PNW, PSW, Inland West	Changes in fire regimes and historical high-grade logging have led to large areas of dense stands. Savanna and complex structures are lacking in many areas, and the amount and arrangement of dead fuels can lead to lethal crown fires that will foreclose their development for centuries.
Western white pine	Inland West, PSW	The exotic white pine blister rust has nearly wiped out the species across its range. Resistant strains have been selected and planted, but there is worry about the narrow genetic base being used. (Blister rust also threatens sugar pine and whitebark pine in these regions.)

Forest Health Concerns by Region and Forest Type

There are many different forest types, but as noted earlier they generally differ between East and West due to the differences in climate, elevation, and geology. Some of the major types, and some of the forest health concerns generally associated with them, are listed in Tables 2 and 3. This is not an exhaustive listing, nor is it meant to suggest that all of any forest type is characterized by the problems listed. This is followed by some brief regional discussions. The regional boundaries are established by the Forest Service, and the basic data and maps of general forest types come from Powell et al. (1993). As will be noted, some of the more extensive forest types, such as ponderosa pine in the West and oak in the East, extend across several regions. The Great Plains region was omitted from the regional roundup, which overlooks the ponderosa pine forests in South Dakota and Nebraska, as well as the riparian hardwoods that inhabit the region.

The regional discussions are included to provide some idea as to the types of forest health issues being discussed by people who know the forests of the region. They are not exhaustive, of course, and much of the discussion in some places focuses on the indications of a forest health problem—insect and disease epidemics, extraordinarily large and hot wildfires, or problems with forest regeneration. Taken together, however, they illustrate the enormous range and complexity of America's forests.

The most general forest health problem across different forest types and regions today is the preponderance of dense forest structures and the lack of an adequate proportion of the savanna, open, and complex structures (Oliver et al. 1997). The reasons for this vary by region, forest type, historical factors, and past management and ownership patterns. Where dense forests dominate the landscape, however, managers are faced with similar challenges, such as:

- Species diversity—in terms of plants, mammals, birds, and fish—is likely to be low, since the dense structure is the least-used of the major structure types. If other structures (such as savanna or complex) are totally absent, species that depend on them may be on the threatened or endangered species lists.
- Plant stress is likely to be observed in the trees, particularly as they grow larger and more competitive. If this begins to kill a few trees or small patches, it may be part of a transition to an understory structure. If it sets up the stand for an insect or disease epidemic that kills most or all of the trees, or if conditions support a wildfire that kills all, succession will begin again as an open structure.
- Where dense stands slow or stop tree growth before the trees reach a merchantable size, the response often prescribed is to thin the trees so that the remaining individuals have adequate light, moisture and nutrients for growth. But often there is little

Spruce-fir, lodgepole pine	PNW (inland); Inland West	Fire suppression has led to larger areas of uniform, dense stands. Lack of open structures and reduced meadow area affects diversity and increases risk of landscape-level wildfires. Wildfires are no more lethal than historical, but less frequent, and much larger when they happen.
Western hardwoods	PNW, PSW, Inland West	Often associated with riparian areas or lowland valleys, many of these forest types have been dramatically reduced by agricultural and urban development; streamside forests are often in need of restoration.
Tropical forests	PSW (Hawaii)	Only fragments remain. Exotic species have replaced most natives, often by more aggressive growth following hurricane disturbances.
Aspen	Inland West	Fire suppression has allowed conifers to invade, while heavy elk and deer browsing has limited regeneration. Aspen reproduces from root sprouts rather than by seed, and there are predictions that much of the region's aspen will be lost unless seasonal fire management is restored and animal populations controlled (Kay 1997).
Piñon-juniper	Inland West	Fire suppression has allowed P-J to expand onto grass and brush lands, increasing soil erosion and runoff due to reduced ground cover. The aggressive root system eliminates grass, making prescribed fire difficult.

*PNW - Pacific Northwest; PSW - Pacific Southwest. See map, p. 31.

Table 3. Eastern Forest Health Concerns

Forest Type	*Primary Region**	*Health Concerns*
Oak	SC, SE, NC, NE	Many oak forest types occur across the East. Savanna and complex structures are missing due to land clearing and logging. Fire regimes have been altered and cannot, in most areas, be restored due to human populations and settlements. Oak regenerates behind fires and hurricanes, and is replaced by other species in the absence of these disturbances. Attempts to preserve complex oak forests have generally failed due to lack of suitable fire regime.
Longleaf pine	SE	Range is greatly reduced due to early logging, removal of fire and replacement with loblolly or slash pine for commercial use. All structures are lacking, but particularly savanna. Restoration efforts are underway.
Loblolly, shortleaf pines	SE, SC	Major timber species in the South, managed largely in young stands, so many areas lack savanna, understory and complex structures. Dense stands develop on nonmanaged lands, increasing stress and epidemic outbreaks of beetles and fusiform rust.

continued

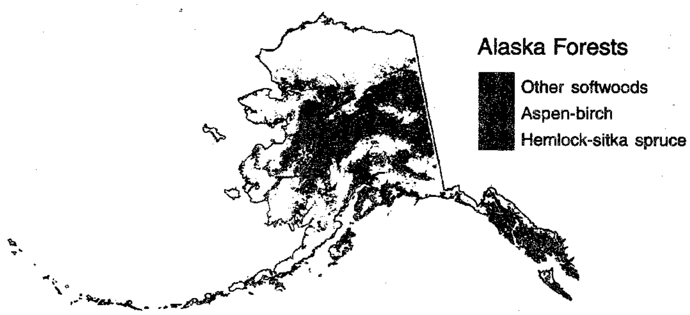
Bottomland hardwoods	SE	Agricultural development eliminated extensive areas of bottomland hardwoods, particularly in the last quarter of the 20th Century. Remaining stands are often fragmented by fields, affecting wetland and habitat values.
Coastal forests	SE	Many of these have been fragmented by development and drainage. Some are threatened by aggressive exotics, particularly those that can out-compete natives in the wake of periodic hurricane disturbances.
Red spruce, Fraser fir	SE, NE	High-elevation species have suffered severe diebacks in recent years, believed to be linked to regional effects of atmospheric pollutants. Pests like balsam woolly adelgid are also involved.
White, red, jack pine	NC, NE	Savanna and complex stands of white and red pine were largely removed by 1900s-era logging; most are now dense and/or understory stands. Currently most are regarded as healthy. Jack pine needs fire regime restored; dense stands of this species are needed for the endangered Kirtland's Warbler.
Spruce-fir	NC, NE	Balsam fir is subject to periodic outbreaks of spruce budworm.
Appalachian hardwoods	NE, SE	Impacted by settlement, logging, grazing, exotic species, and air pollution, these forests face significant risks. Chestnut, once half of the forest, is no longer viable; dogwood and butternut are in decline. Oak has been replaced by maple and other shade-tolerant species in many places. Often fragmented into small ownerships with limited management. Most stands are dense—open, savanna, and complex structures are rare.
Maple-beech-birch	NE, NC	Sugar maple decline has been controversial, with official surveys showing little decline while concerns continue to be raised. Suspected causes include air pollution, drought, insects and diseases, but there is little agreement, indicating a prolonged forest health debate in some areas.

*SC - South central; SE - Southeast; NC - North central; NE - Northeast. See map, page 31

Alaska[1]

Alaska is a unique region, a huge frontier with few people and an enormous forest resource in large blocks. Most of the forests are slow-growing boreal forests—birches, willows, and spruces. Over 83 percent of Alaskan forests are classified in forest data as "nonproductive," or "other forest"—land that produces less than 20 cubic feet of wood per acre per year. Along the coastal areas of Southeast Alaska, however, reside the northernmost giants of the temperate rainforests that blanket the coastal slopes between Alaska and California. Federal agencies control 60 percent of the Alaskan forests. About 9 per-

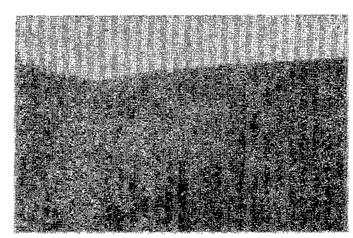
[1] Map reproduced from, and statistics derived from, Powell et al. (1993).



cent of Alaska's forests are within the National Forest System. Native corporations control large blocks of the remainder, and the "other public" includes state and borough lands. There are few individual nonindustrial owners, and no industrial forests in the state.

The major forest health problems are currently associated with large expanses of Sitka, Lutz, and white spruce that have been affected by spruce beetle epidemics and now pose enormous wildfire hazards. It is estimated that over 1 million acres were affected by insects in 1996, with much of the damage occurring in the Kenai Peninsula. The area of insect damages reported is expected to drop in the coming years, as the amount of susceptible live spruce forest diminishes. Some professionals express concern and uncertainty over the future of these forests. Once dead, they will almost certainly burn. The question is whether the heavy fuel loads will result in severe damage to soils. Without fire, or with fire of unusual intensity, many of these places will revert to grass or brush fields for decades or centuries. Some of these forests are, insofar as is known, the first forest on this land since the glaciers receded, and little is known about the successional processes that might occur. Almost 2 million acres were affected by wildfire in 1997, but information on the estimated long-term impacts is not yet available.

Action to head off wildfires and large die-offs is constrained by large, remote areas, federal ownership, and no economic market for the small trees produced in thinning and fuel reduction. Changing these situations is extremely difficult in remote areas, so management options are limited even where federal land use restrictions are not involved.



Dense stands of Alaskan spruce are susceptible to large-scale insect epidemics that set the stage for huge fires.

Because recent years have experienced mild weather, beetle emergence has occurred in May, weeks earlier than usual, enabling the insect to complete its life cycle in one year instead of two. This has been postulated to be connected to climate change, and it will create serious problems for the forests if beetle populations explode. Amid the speculation about the potential effects of climate change, one possibility is that a warmer climate might be seen largely in slightly warmer winter temperatures at high latitudes, perhaps accompanied by slightly longer growing seasons. One possibility is that this will be good for forests—a longer season for growth. Another possible effect, however, is not so good—a longer growing season that tips conditions in favor of a pest species. Alaskan forests may be one place where scientists get the opportunity to watch change and do research that can answer these questions more fully.

Major forest types on unreserved forest land, Alaska

Major Forest Type	*Estimated Area (1000 ac)*	*Percent of total forest*
Other softwoods	60,750	51
Fir-spruce	26,662	25
Western hardwoods	19300	16
Hemlock-Sitka spruce	8,526	7
Other forest types	325	1
Total unreserved forest	**118,563**	**100**

Pacific Northwest

There is a wide diversity of forests in the Pacific Northwest, but in general they are divided by the crest of the Cascade Range that runs through Oregon and Washington. On the western side grow some of the most magnificent forests on earth, occupying some of America's most productive forest sites. Here, forest health conditions are heavily influenced by long-running battles to preserve remaining areas of old-growth. The massive Douglas-firs can live for several hundred years, and many of the forests feature even-aged trees—300 to 400 years—indicating that they emerged from a major disturbance (possibly a major windstorm followed by fire) in the past. Many areas of old growth have been set aside in wilderness areas, parks, and other reserves, and they may remain in this condition for many years before falling victim to a major disturbance. At some point, however, they will need to be replaced (in terms of complex, or old-growth structures) by younger forests to retain regional structural diversity.

On the eastern side of the Cascades, conditions are drier and hotter in summer and colder in winter, leading to forests that resemble those of the intermountain region. Many lower-elevation forests were once ponderosa pine savannas; these have been largely eliminated by farming, logging, and fire suppression. Today, most of the remaining pine forests are in dense structures, susceptible to insect and disease outbreaks as well as lethal wildfires.

The mixed conifer forest types have various health problems, depending on their location and structure. Again, having most of the stands in the dense structures is a prob-

lem for landscape and habitat diversity in the region, as well as a precursor to insect, disease, and wildfire problems.

The region has an excellent potential for diverse approaches to managing forests and a large economic base upon which to maintain forests. The forest products industry has a larger presence in Oregon and Washington than anywhere else in the West (60 percent of the industrial forests in the West are here) and NIPF owners enjoy economic incentives for maintaining forests in good condition. Much of the industry, however, was developed to process wood from public lands. That supply has been greatly reduced, so the industry has shrunk and looks increasingly to private lands for its timber supply.

This shrinkage of the forest economy and public management trends may result in the loss of an ability to sell wood from public forests. Large areas will be undisturbed by harvesting but will face the risk of equally large die-offs and fires as forest changes con-

Major forest types on unreserved forest land, Pacific Northwest region

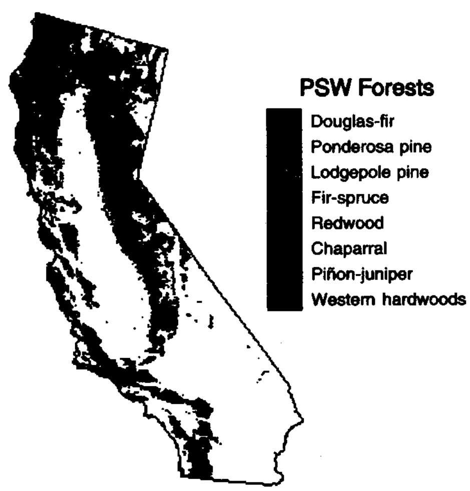
Major Forest Type	*Estimated Area (1000 ac)*	*Percent of total forest*
Douglas-fir	19,927	45
Ponderosa pine	7,480	17
Fir-spruce	4,294	10
Western hardwoods	4,154	9
Other forest types	8,110	19
Total unreserved forest	**43,965**	**100**

tinue. Responding to these conditions will mean fighting for federal money to pay for manipulating vegetation that has little or no economic value. One prospect might be to encourage the development of a biomass energy industry that could take the unmerchantable material as part of fuel treatments. Another is to let whatever happens happen, then spend large sums out of an emergency budget to fight fires and protect communities. Another option may be the rebuilding of the infrastructure of mills and loggers at some future date, if public support swings once again in favor of more intensively managed federal forests.

Pacific Southwest

California forests range from lush conditions with enormous trees to dry situations where forests are marginal. They are also intermixed with major human populations in many areas. These volatile situations experience periodic wildfires that can be exceptionally destructive, particularly in dry areas where unmanaged forests are mixed with residential areas.

Preserving remaining stands of sequoias, redwoods, and areas of old-growth are continuing issues in California. Big population centers in dry zones draw massive amounts of water from the forested mountains, creating an interest in maintaining the value of forests as watersheds. Changes in forest composition (from savanna to dense mixed conifers, for example) may have had a significant effect on watershed and hydrologic conditions, although there is little data on past conditions with which to make good comparisons. In a



Major forest types on unreserved forest land, Pacific Southwest region

Major Forest Type	*Estimated Area (1000 ac)*	*Percent of total forest*
Western hardwoods	9,888	29
Fir-spruce (mainly fir)	6,188	18
Chaparral	5,890	17
Ponderosa pine	5,171	15
Other forest types	6,970	20
Total unreserved forest	**34,085**	**100**

continuing debate over forest management, local California groups are pointing out that while timber sales result in some revenue for reinvestment in forest conditions, downstream water and power users pay nothing for forest management that protects their water supplies. Some observers feel that if water production could somehow generate forest management revenues, California forests could be managed to better accommodate water needs and become healthier in the process.

Emissions from urban centers and their effects on adjacent forests are considerable. Where the forests are fire dependent (as are most inland California forest types), those not managed for forest products need fuel treatment and prescribed fire to reduce extreme wildfire hazards. The health and visibility effects of smoke limits prescribed fire in many areas, and there is considerable public opposition to mechanical fuel treatments, which often require roads. Where neither option is available, managers have little choice but to allow fuels to continue to build toward hazardous levels.

California has a wide variety of hardwood species that once covered large areas of lowlands that are now the site of intensive agricultural and urban development. It is estimated, for example, that riparian woodlands in the Sacramento Valley currently occupy only one to two percent of the land they occupied in 1850. The oak and chaparral ecosystems along the Pacific Coast developed under a regime of fairly frequent fire, and did not tend to build up huge fuel loads until fires began to be suppressed. Without regular fire management, these fuels can support—as demonstrated by the 1993 fires near Los Angeles—huge, deadly wildfires.

A sizeable forest industry in California and significant NIPF ownerships creates an economic base for maintaining forests in good growing condition in areas away from urban centers, but this industry is under pressure from large urban populations wanting undisturbed forests. Forest management on private land is regulated by the most stringent forest practices act in the country.

Hawaii

Forests in Hawaii provide scenic backdrops for a tourism economy. Protecting the remaining native forests and dealing with the effects of exotics are primary concerns. Exotics now outnumber native species, and there is a movement to try to renovate native ecosystems by controlling exotics and reforesting areas such as farmland that is no longer used for sugarcane production. Tourism is the driving force behind native forest restoration, since there is almost no forest industry. Growing biomass for energy production could, at some future point, become important to the economy of the Islands.

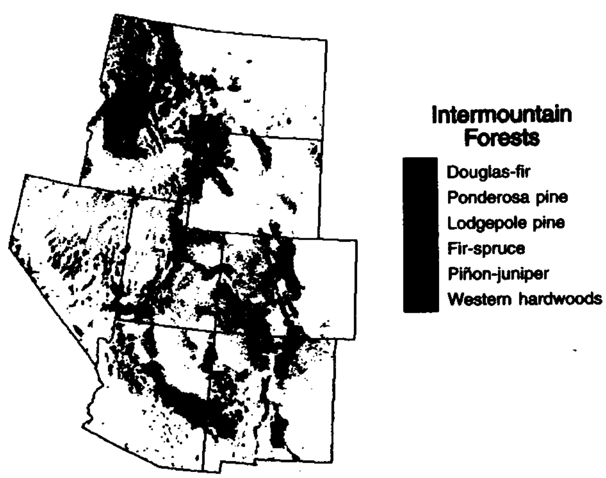
Success in controlling some of the most damaging exotics (such as feral pigs and goats) will depend on consistent public funding over the long haul.

Intermountain

In this generally arid region (often called the Inland West, to include similar forests in eastern Washington, Oregon, and California), the forests grow in the snow and rain-catching mountains. Most people live in the valleys, where they rely on mountain watersheds for municipal, agricultural, and power-generating water.

Cold winters and dry summers restrict microbial decomposition of dead wood and other vegetation, and most of the carbon recycling must be performed by fire. Suppressing historic wildfire patterns has led to a buildup of dead and dry leaves, twigs, bark flakes, and other litter that provide fast-burning fuels and volatile, dangerous conditions in many areas.

There is great interest in protecting forest watersheds for water supply, wildlife, and recreation. In their current condition, many forests face big die-offs and lethal wildfires that can damage both watersheds and human health. In large, remote areas, such treatment requires road construction, which can have negative impacts on watershed and wildlife conditions. There are few easy answers to these complex trade-off issues.



Aspen needs periodic fire to remove conifer competition and encourage resprouting. Cutting and burning patches is an attempt to mimic that process on BLM lands in Wyoming.

Federal ownership and projects dominate the region—70 percent of forests are federally owned. Federal dams and lakes attract intense recreation activity. Mountain recreation—primarily skiing—attracts a worldwide clientele, bringing burgeoning populations into remote mountain valleys with fairly limited human carrying capacity. High quality-of-life values, coupled with modern communications and access to regional airports, attract a fast-growing population of "lone eagles"—professionals who can work anywhere their computers will function.

Low-elevation forests adapted to a historical regime of frequent, low-intensity fires are now mainly dense forest stands that support large, lethal wildfires. Where super-hot fires occur, forest recovery may be slowed or absent on the damaged soils. There's also considerable potential for economic damage and loss of human life. Areas of rapid population growth often overlap closely with areas of high wildfire hazard. Forest health, wildfire, and population growth are entwined in a complex pattern of rapid change. Addressing forest health questions with intentional treatment has been difficult, even where public opinion supports action. Cumbersome federal decision processes—coupled with intensely controversial political battles over wilderness, endangered species, roadless areas, timber harvest, and salvaging dead timber—tend toward gridlock. This is exacerbated by enormous distances, remote

Major forest types on unreserved forest land, Intermountain region

Major Forest Type	*Estimated Area (1000 ac)*	*Percent of total forest*
Piñon-juniper	41,667	35
Douglas-fir	15,754	13
Ponderosa pine	15,278	13
Fir-spruce	12,975	11
Western hardwoods	12,484	10
Other forest types	9,863	8
Total unreserved forest	**119,016**	**100**

and isolated forests, and a weak forest products industry, diminished in recent years as federal timber sales dwindled.

Even if those problems were solved, there is still the challenge of disposing of the excess biomass that needs to be removed to restore fire-tolerant conditions. Much of the excess is only suited for energy production and today's biomass technology cannot economically compete with natural gas and coal. Unless biomass energy can be made feasible, the region has few treatment options. After the inevitable wildfires, some land may return to forest over the coming decades. Some could also, under adverse weather, deteriorate into brush fields or desert due to soil damage. The risks are high, and the decisions difficult.

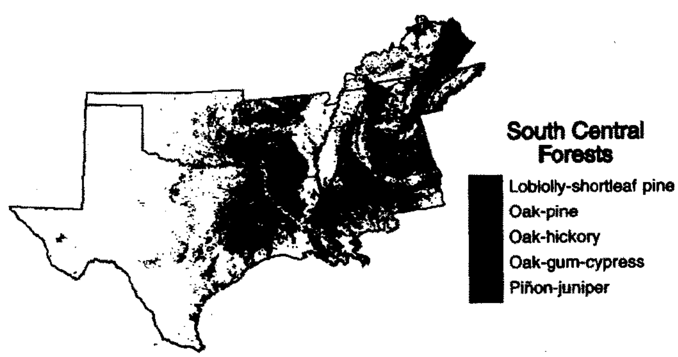
South Central

The South Central region features resilient ecosystems with fast-growing tree species that have become a major part of the Nation's wood supply. Soils, climate, and ownership patterns favor timber management as a primary use of these forests.

Most South Central forests are young, reestablished on land that was cleared for cropland in the past. Large acreages are intensely managed and harvested in short cycles for wood products. Few areas remain in the savannah or complex structures historically common in the region.

As the forest products industry encourages sustainable forestry, and states promote voluntary "best management practices" to protect water quality, plantation forestry becomes increasingly concentrated on the better forest soils, away from streamsides and water bodies. Leaving "streamside management zones" to grow a more diverse mix of species and develop older, larger trees introduces additional habitat and structural diversity into the forests of the region. On many of these landscapes, intensely managed plantation forests support a high diversity of wildlife populations that appear to thrive under the conditions.

Five states in this region have more than 3 million acres each in industrial forests, and NIPF ownerships hold most of the remainder. There are population concentrations in large



Major forest types on unreserved forest land, South Central region

Major Forest Type	*Estimated Area (1000 ac)*	*Percent of total forest*
Oak-hickory	51,431	42
Loblolly-shortleaf pine	25,706	21
Oak-pine	18,669	15
Oak-gum-cypress	15,545	13
Other forest types	11,359	9
Total unreserved forest	**122,710**	**100**

cities, but people are well spread into and around forest areas, creating many interactions with wood production as well as recreation. A flourishing hunting lease economy encourages game species habitat enhancements.

Where populations are growing and becoming increasingly urbanized, the public acceptability of forest management practices like prescribed burning comes under pressure. There are also significant restrictions on management of wetlands and legal requirements for protection of endangered species such as red cockaded woodpeckers.

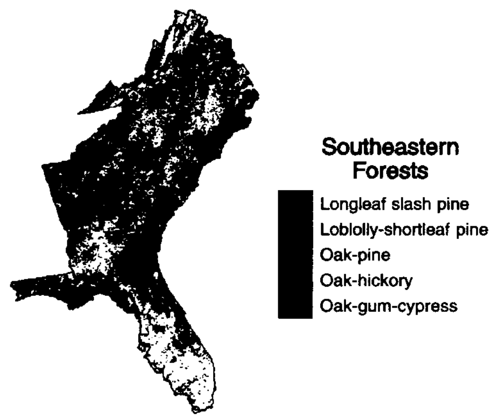
Industry needs are changing too: the focus has shifted to include more hardwoods, particularly for use in the paper and pulp industry. With fewer large trees harvested in the West, southern lumber is being asked to fill the void. The mix of industry, millions of private owners, and federal and other public ownerships encourages diverse approaches to maintaining South Central forests in good growing condition, and there are strong economic rewards to pay for many forest practices.

Economic and ownership patterns are generally in place to maintain large areas of flourishing forests. But these forests require intensive forestry to keep them from developing such dense structures that plant stress triggers major insect and disease epidemics or die-backs. Increasingly urban populations not tied to the land are seeing these management methods as "not natural" and restrictions are rising in many areas. Where management has changed on public lands in response to these restrictions, there are increasing concerns over insect infestations and fires that start in fuel-heavy public areas, then spread into private forests.

Southeast

Southeastern forests resemble those in the south central region—resilient ecosystems, fast growing trees, and important wood production. Soil, climate, and ownership patterns favor maintaining forests in commercial production, but many areas are experiencing rapid population growth, particularly near urban concentrations. This is changing prevailing public attitudes of how forests should look and what they should produce. Population growth also increases pressure toward fragmenting NIPF ownerships into smaller pieces.

Most of the region's forests are young, reestablished on former cropland that was abandoned in the 1930–1970 period. Most pine forests are in plantations, intensely man-



aged and harvested in short cycles. Where pine was not replanted after harvest of the original plantations, hardwoods predominate. In the Great Smoky and southern Appalachian mountains, hardwood forests include both recovering agricultural lands and some of the oldest forest ecosystems on the continent.

Privately owned forests dominate the region. Outside the major urban centers, people live in close contact with forests, creating many interactions based on wood production, although recreation is important as well. Hunting leases help pay for land and habitat maintenance on private forests.

Maintaining commercial southern pine forests involves use of prescribed burning and other vegetative manipulations ranging from herbicide treatments to frequent harvests and planting. These activities may draw public opposition as the region becomes increasingly urbanized.

Major forest types on unreserved forest land, Southeastern region

Major Forest Type	*Estimated Area (1000 ac)*	*Percent of total forest*
Oak-hickory	25,784	30
Loblolly-shortleaf pine	21,367	25
Oak-gum-cypress	12,461	14
Longleaf-slash pine	10,965	13
Oak-pine	9,928	12
Other forest types	5,575	6
Total unreserved forest	**86,080**	**100**

States in the region generally do not have forest practices acts to regulate private forest management, but all have adopted voluntary "best management practices" (BMPs) that can help landowners protect air and water quality, wetlands, and endangered species.

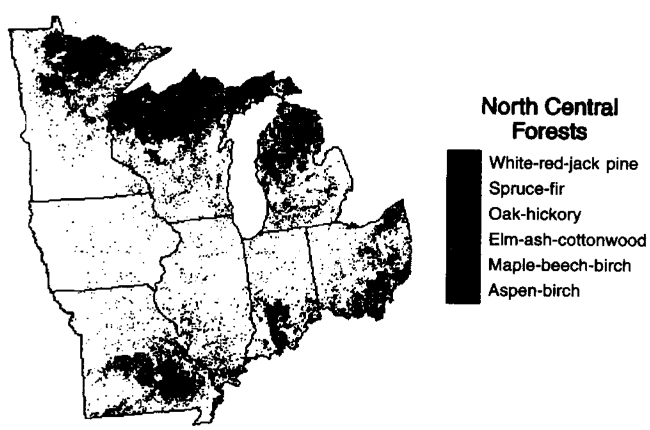
Industry's efforts to achieve sustainable forestry include an outreach to the nonindustrial owners that supply the majority of the region's wood. This has been reflected largely in informational materials provided to landowners, and a widespread effort, in cooperation with educational institutions and organizations, to train loggers in environmentally sound and sustainable logging methods.

The mix of industry, small private owners, and public land encourages diverse approaches to maintaining sustainable forests, and there are strong economic incentives for forestry practices. This, combined with the preponderance of young, intensively managed forests, leads to healthy forest conditions. A major threat comes from increasing fragmentation, as a rapidly growing population meets its needs for land ownership by dividing forest parcels into smaller sizes. Developing new technologies for managing small holdings is a challenge. Without management, many of these forests will develop the dense structures, stressed plant conditions, and extreme wildfire risks identified elsewhere.

In plantations established on previously damaged agricultural soils, drought can cause stress leading to insect outbreaks, particularly on lands where management is lacking. In some mountainous areas, high-elevation forests have experienced diebacks that are attributed to atmospheric pollution and deposition.

North Central

North Central forests interact intensively with human populations throughout the region. There is considerable mixing of naturally regenerated native species, planted native species, and introduced exotics. The air, rain, and snow affecting many forests is chemi-



cally altered by emissions from large populations and industrial concentrations using massive quantities of energy and other raw materials.

Overall, 64 percent of the region's forests are divided into millions of nonindustrial private forest ownerships. Michigan, Wisconsin, and Minnesota have large blocks of industrial lands and big federal holdings too, but other public ownerships (state and local) are very significant parts of the picture. In Minnesota, other public lands are as large as the total NIPF holdings.

An overall ratio of 147 acres of forests for every 100 people in this region is close to a sustainable situation where area forests could supply resident-population needs for forest benefits ranging from clean air and water to aesthetics, recreation, and timber on a renewable, long-term basis. This is heavily dependent upon the maintenance of large blocks of forests in Michigan, Wisconsin, Minnesota, and Missouri.

The region leads the Nation in paper making. Aspen forests that grew back after the widespread clearcuts and fires of the late 19th and early 20th centuries are extensive. The above-ground portions of this species declines in vigor at an early age (compared to many tree species) and renews itself by re-sprouting from its long-lived and extensive root system. It has been theorized that some of these aspen clones may be among the largest and longest-lived plants in the forest, with a single plant covering many acres and living hundreds of years. Where heavy conifer invasion or excess animal browsing prevents sprout survival, however, these forests are at risk. Harvesting and prescription fire that mimics historic processes, in addition to control of large animal populations, may be needed to assure sustainable aspen forests.

The region exhibits a lack of savanna and complex structures, a result of past settlement, agriculture, and logging. Recovery has been slowed by the soil damage from repeated wildfires after early logging, but is showing progress as time passes and improved management techniques emerge.

The high incidence of state and locally owned forests in the Lake States creates unusual dynamics. These other public ownerships hold forests for public uses without some of the conflicts between national and local goals found with federal lands. Exceptional hardwood forests exist in parts of Missouri, Ohio, Indiana, and Illinois. Species such as

Major forest types on unreserved forest land, North Central region

Major Forest Type	*Estimated Area (1000 ac)*	*Percent of total forest*
Oak-hickory	25,313	32
Maple, beech, birch	17,837	22
Aspen-birch	13,123	16
Spruce-fir	8,781	11
Elm-ash-cottonwood	7,624	10
White-red-jack pine	4,087	5
Other forest types	3,319	4
Total unreserved forest	**80,084**	**100**

black walnut and white oak grow well here, mostly on private nonindustrial lands.

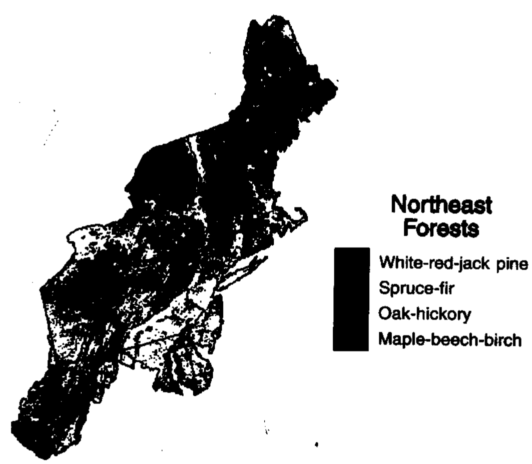
Economic and ownership patterns are in place to maintain large areas of flourishing forests. There is considerable fragmentation pressure, particularly on nonindustrial forest land. But large industrial ownerships in the north and extensive state and local holdings will keep millions of acres in forests. That, and the high value people place on forest recreation, suggests a bright future for the region's forests.

Northeast

Northeastern forests have reclaimed millions of acres of once-cleared land as the region's population moved from agrarian-rural to urbanized. The forests are a mix of naturally regenerated native species, planted native species, and introduced exotics. Today's forests grow on soils churned by glaciers and worn thin by colonial farmers. They are immersed in air altered by chemical emissions from the Nation's industrial heartland. Forest ownership patterns range from small private backyards and public parks in cities, to never-settled expanses of wild land in the largest blocks of forest industry ownerships in the U.S. (more than 8 million acres in Maine). Overall, 70 percent of the forests are divided into millions of nonindustrial private forest ownerships.

The overall ratio of 144 acres of forests for every 100 people in the northeast appears close to a situation where northeastern forests could supply resident-population needs for benefits ranging from clean air and water to recreation, aesthetics, and timber on a sustainable basis. This depends mainly on the large blocks of forests in sparsely populated Maine, Vermont, West Virginia, and New Hampshire.

Industrial owners hold more than 10 million acres of northeastern forests in large blocks. Although some dislike the outward appearance of large-scale forestry, there are overall environmental benefits to the public from having such large land areas maintained



as growing forests. There is considerable political pressure, however, to increase public control through regulations and outright purchase.

Public ownerships—other than federal—control 12 percent of the northeastern forests. There are significant areas in these categories: state-owned lots in Maine; the Adirondacks Preserve in New York; state forests in Pennsylvania. The urbanized states of Massachusetts, New Jersey, and Connecticut also have significant areas in other public ownerships. There is strong public support for maintaining the recreational aspects of these ownerships and equally strong opposition to dealing with forest health conditions through active management.

In many areas of the region, particularly in the hardwood forests, effective game management laws have helped whitetail deer populations explode to the point where forest regeneration has become seriously affected. Many forests are now composed almost entirely of older trees, as no young trees can survive the animal browsing. Unless deer populations are controlled or seedlings are protected from them, future forests will be composed mainly of species that deer avoid.

Responses to forest health conditions will be diverse because of the large numbers of owners with different land use objectives, but it is generally true that applying expertise and management to these forests will be increasingly difficult as the ownerships become smaller. Exotic species will continue to affect the region's forests, due to the region's large through-put of imported materials and the effect of forest fragmentation associated with human settlements. A major concern for the fate of many forest neotropical bird species revolves around the fragmentation of their summer nesting areas, increased predation by dogs and cats, and competition from human-attracted species like cowbirds.

Pressure for hands-off management (especially for large ownerships) may create new forest health conditions. Some regulatory proposals for Maine's industrial forests could force reversions to large expanses of balsam fir, followed by recurring budworm epidemics creating expanses of dead trees, fire hazards, economic losses and adverse environmental effects.

Major forest types, unreserved forest land, Northeast region

Major Forest Type	*Estimated Area (1000 ac)*	*Percent of total forest*
Maple, beech, birch	28,205	35
Oak-hickory	24,157	30
Spruce-fir	10,203	13
White-red-jack pine	7,437	9
Other forest types	10,541	13
Total unreserved forest	**80,543**	**100**

Managing for Healthy Forests

A forest is an exceedingly complex biological unit. It comprises not only a more or less diversified aggregation of trees, but numerous species of shrubby and herbaceous plants, fungi, insects, herbivorous animals and a complex soil fauna and flora. In other words, it consists of a very large number of mutually interacting organisms which are affected by, and themselves affect, a complex of environmental factors.

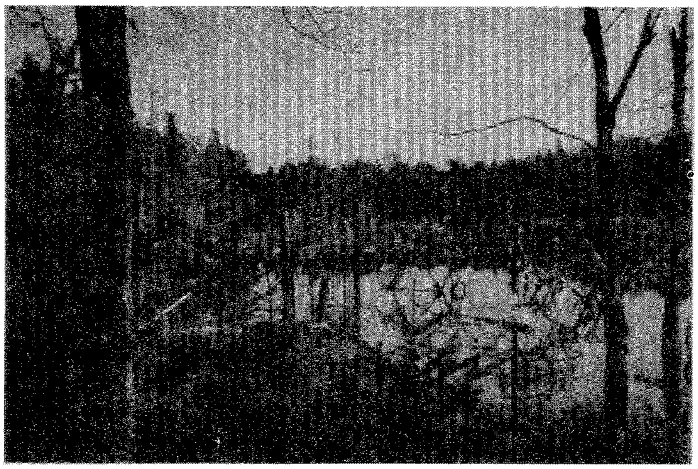
Those words could have been written today, but they come from a 1929 report on forestry research coauthored by I.W. Bailey of Harvard University and H.A. Spoehr of the Carnegie Institution. This insightful report goes on to describe the fact that, while much of forest management depends on the modification of the forest through treatment of the forest vegetation itself, the manager must be skillful because:

. . . such gross treatments have highly diversified and far-reaching effects upon the biology of the forest, not only upon the soil and the trees but also upon the minor vegetation, insects, fungi, and other elements of the complex. The latter effects cannot safely be ignored since they in turn may later profoundly influence the future growth of the forest.

Today, three professional generations after Bailey and Spoehr's advice, the attention of forest managers is focused on how best to do the things they do in a forest so that when they "profoundly influence" its future, that future is healthy and sustainable. What today's managers enjoy (that Bailey's generation lacked) is a better basis for understanding forest ecosystems and how they function, as well as vastly more sophisticated tools to model and predict what kinds of forest responses may result from a given action.

That understanding includes better methods to evaluate conditions over large areas so that individual actions can be placed in the context of landscape or regional effects, and better methods to portray what will happen over longer time periods, so that people can see the long-term effects of a particular management action (Oliver et al. 1994). These are enormously complex systems, so saying that people today "know more" is not meant to imply that they know it all, or that they know enough. Most experts still advise addressing forest management questions as an exercise in experimental design, designing each action on the basis of the best hypothesis available, but doing enough monitoring so that one learns from the outcome.

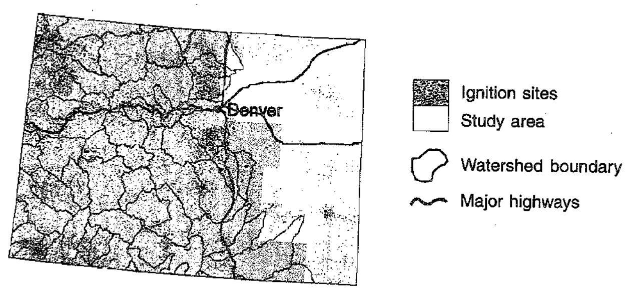
These new tools, however, applied in conjunction with basic ecosystem management concepts, can help people better realize how short-term changes to organisms or populations (cutting some trees or affecting vegetation with a prescribed fire program) may affect forests, landscapes, and even larger areas over longer time periods. People are often



Wetlands are an important component of forests, and retaining wetland quality is one of the management objectives on this northeastern forest.

repelled by the sight of a cougar killing a deer, or a logger cutting down a tree. Those actions, lethal in the immediate, local sense, may be contributing to the long-term integrity of larger landscapes. On the other hand, if they are done wrong or taken to extremes, those same actions may be destroying the long-term integrity of the forest. Understanding the differences involved is a critical factor in achieving forest health treatment that contributes to a sustainable forest.

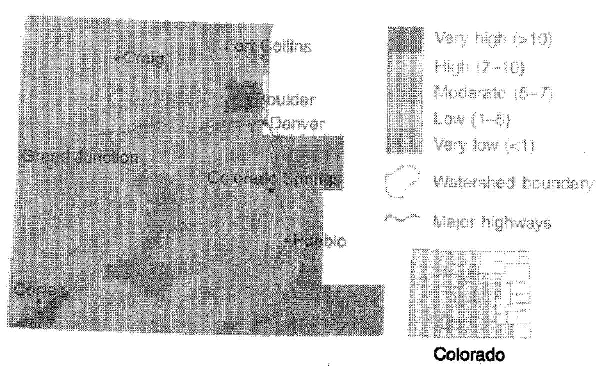
One example of modern capability is the availability of computer models based on expert systems. These models allow a person to simulate the likely effects of a management action or disturbance into the future. Graphics drawn from the Landscape Management System, developed by the University of Washington in cooperation with the Forest Service, are shown on pages 7–9. This program, which is available free of charge on the World Wide Web at *fttp://silvae.cfr.washington.edu*, can produce images that illustrate not just how a forest system may change, but how it will appear, in the future. It is available for only a few forest types however, and a great deal of data about forest growth and successional processes is required to adapt it to new forest conditions. Fortunately, many people are at work developing such tools and they are rapidly becoming available. With tools like these, forest managers can more accurately predict the outcome of actions. For a skeptical public, who want to see productive forests but lack the expertise to envision long-term effects, the programs provide a way to gain information and confidence about different management approaches.



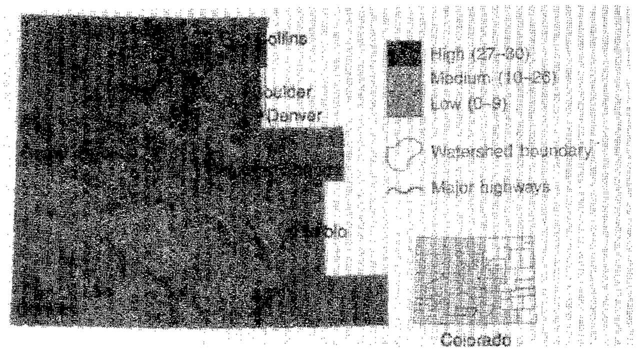
Fire ignition locations as reported by fire agencies are entered into a geographic information system (GIS) as the basis for a wildfire hazard assessment.

The other approach that is gaining increasing usage is the concept of risk assessment. None of us would buy a stock offering, drive a car, or mortgage a home without thinking of the risks involved. While we aren't hoping for a market crash, car wreck, or financial reversal, we realize that those can happen. So we evaluate the level of risk that we are willing to accept, and pay for some kind of insurance or other safeguard to cover the unlikely, but catastrophic, events we wish to avoid.

Forest managers today have the same opportunity. The growing capability of aerial imagery, computer modeling, and ecosystem understanding allows managers to identify places where risks are highest and explore courses of action that are likely to reduce risk. One such example was recently demonstrated in a wildfire hazard/risk modeling exercise conducted in the State of Colorado (Sampson et al. forthcoming). This exercise used a 10-



The probability of wildfire ignitions in different watersheds is indicated by the number of ignitions per 10,000 acres over the past 10 years.

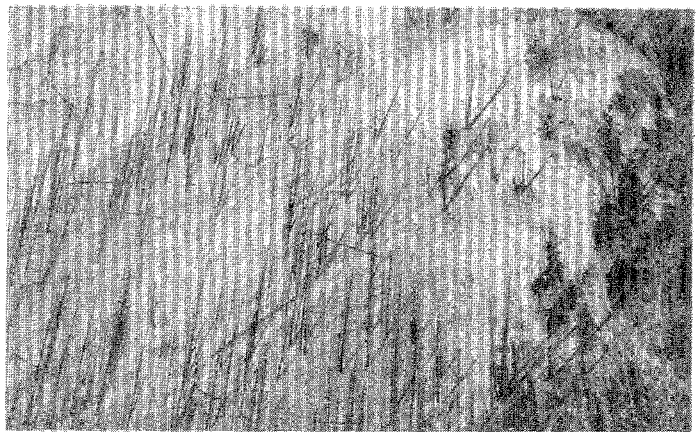


Using soil, slope, climate, and vegetation data, scientists can evaluate the risk of serious watershed damage in the event of a wildfire.

year fire ignition history—combined with satellite imagery of vegetation and data on soil types, climate, elevation, and hydrology—to identify the wildfire hazard by watershed area. The probability of a future ignition that could grow into an uncontrollable wildfire is reflected by past records that show where ignition history is highest and vegetation most likely to support an intense wildfire.

Knowing the areas most at risk from large wildfires does nothing to predict events in the near future, but it allows managers to take a closer look for areas where treatment might be the most effective at reducing hazards. A modern geographic information system (GIS) allows the user to locate past events on the landscape, and combine them with the current conditions that might affect fire behavior. In addition, the GIS allows the study of "distributed risk," or the risk one area faces because of the conditions in an adjoining area. Thus, if one place in a watershed faces a very high ignition risk, and the entire watershed is covered with flammable vegetation, the chances of the entire watershed being affected are very high—even if the ignition risk is isolated in one small area.

Using soil, slope, vegetation, and fire effects information, the model also illustrated areas where soils might be most susceptible to development of hydrophobic (water repellent) conditions if they were subjected to intense wildfire. Hydrophobic layers can be created when the heat of a fire volatilizes organic compounds from the vegetation and drives some of them down into the soil. As the heated compounds move down through soil pores, the soil cools them until they condense, leaving a waxy organic residue. In soils with limited pore space (mainly coarse-textured soils), these compounds can seal the soil, creating a water barrier that lasts for a year or more until the compound breaks down or new roots penetrate and open up the layer. If rainfall or snowmelt occurs before the hydrophobic layer is broken down, the top layers of soil will become saturated, then start to flow downhill under the pressure of the excess water. The result can be damaging soil erosion, coupled with sediment and debris flows that affect stream channels and reservoirs far downstream (See page 37).



A very hot wildfire in 1994 left these mountain soils badly damaged and hydrophobic (sealed against water penetration). A normal rainfall in the summer of 1995 caused severe soil erosion and debris flows into streams below.

While tools such as this offer increasing insight into the risks inherent in current or predicted forest conditions, it is important to note that major gaps in our knowledge still exist, as well as major limitations in the feasibility of treating certain forest conditions or restoring forests after some kinds of damage. Any risk assessment, no matter how well conceived, can be thrown into immediate disarray by an unforseen natural disturbance. (The Colorado wildfire modeling exercise, for example, estimated that the forests in the northcentral watersheds faced only a low hazard. The 1997 blowdown of 20,000 acres of spruce in an unusual windstorm may have significantly changed that situation, at least in one place. Events like this are known to occur historically, but the chances of accurately assessing the risk—or managing it if one could assess it—are minimal.)

Another important factor is the inherent limits of different ecosystems. A pine forest in the southeast may, after harvest and replanting, be a vigorous young forest again within two-three years. On a dry, sunbaked south slope in the Inland West, a similar clearcut pine forest may be virtually impossible to restore, as the altered microclimate becomes too harsh for seedlings to endure. Similarly, a wildfire that depletes soil nutrients and organic matter may, on a marginal site, deplete the soil to the extent that reforestation may not occur for generations, if ever. Where the soil starts into a downward spiral of erosion and degradation, the site is more likely to become desert-like in the future than it is to return to its original condition. Once that process begins, the chances of reversing it and restoring the site are pretty low in most places, even with heavy investments of expertise and money. The limits we face may be lack of knowledge, or simply the fact that the forces of nature in some places are overwhelming. Whatever the case, it is well to remember that limits exist when the growing confidence of scientists and managers begins to sound as if all such obstacles had been conquered.

Much forest management in the past was focused on producing useable supplies of wood, forage, or wildlife from the forest. Early exploitation took advantage of established forests with little or no regard for the future. Those actions reflected largely local, short-term considerations. As conservation pressures increased throughout the 20th Century, people initiated major efforts to restore damaged forests through tree planting and fire protection. In the management of existing forests, conservation concerns led first to the concept of sustained yields, then to the more recent focus on sustainable forest systems. People's thinking about forests and their future has become increasingly longer-term.

It is the longest-term framework—sustainable forests—that shapes today's forest health treatment efforts. The problems addressed are complex, and usually tied to a particular place and the conditions that exist there. Standardized management approaches are seldom the most useful, and any approach can become a problem when it is applied in the wrong place or in the wrong way.

There are, however, some general factors that seem to be common in addressing forest health questions. Often, these are similar to the factors cited in recent attempts to define ecosystem management. They include:

- Maintenance of a plant community (in terms of composition, size, arrangement and density) that is suited to the environmental conditions (soil, microclimate) on the site.
- Protection of basic soil quality and productivity.
- Protection of genetic and biological diversity within the forest.
- Management to achieve an array of structural conditions across time and space.
- Maintenance of essential ecosystem processes such as fire, nutrient cycling, carbon cycling, and water partitioning within the system.
- Consideration of cumulative effects over time as well as landscape and regional impacts.
- The need to create disturbances where needed to mimic missing events or features in the system (such as a lack of fire, or missing predators).
- The need for a good monitoring system to provide the information needed to effectively adapt management and treatment to changing conditions within the forest.

Using tools ranging from satellites to grub hoes, forest managers attempt to evaluate forest conditions, establish what they would like to see in terms of future conditions, then take the actions seen as most likely to lead toward that desired future. Often, those actions will involve changing the vegetation on the land. Trees, brush, or grass can either be planted where desired, or removed where it interferes with desired conditions (within limits, as noted above). Domestic livestock or wildlife numbers can be adjusted to change grazing patterns. People and their impacts can be channeled to or away from certain areas by constructing or closing roads, trails, or campgrounds (not as easy as it sounds, in many cases).

None of these actions can be labeled "good" or "bad" for forest health without consideration of the location where each is proposed, the current conditions on that site, and

A modern feller-buncher moves among a mixed conifer forest in California, removing the small trees that crowd around large trees.

the forces that are affecting and changing it. That becomes a major challenge in establishing public policy, particularly as it applies to the public lands. Where people trust the land management agency to do the right thing, rules can be few and agency discretion broad. Where that trust has eroded, however, rules replace discretion. When conditions on the forest change faster than the rules can be adjusted, or in ways the rules did not foresee, managers can't adapt, and forest health often suffers as a result.

In many cases across America today, the type of treatment indicated by modern ecosystem science and existing forest conditions may not be acceptable under the current rules. Where we have determined that forests will be largely unaffected by human actions (e.g., parks and wilderness), little if anything can be done to head off forest changes. For some people, that is a major benefit, as it allows observation of what nature does on the land without the intervention of people. For others, it is a major problem, encouraging resource waste and allowing needless damage to occur.

These different values can lead to significant controversy over forests and forest management. Usually, that controversy focuses on environmental and economic arguments, designed to persuade decision makers to either change or protect the legal status quo. Science can help inform the debate, by explaining the meaning of current conditions in light of what the future may hold for the forest. But science can only inform the debate. People's values, and how they change from place to place, situation to situation, and generation to generation, hold the final key.

Appendix A. Forest Data

The following data tables have been constructed from data developed by the USDA Forest Service. The presentation has been altered slightly to provide additional relevance to forest health considerations. The forest land area (Tables A-1a and A-1b) was derived from *Forest Statistics of the United States, 1992,* and indicates a total forest land area 1 million acres larger than is contained in Table 2 of the 1992 RPA publication, *Forest Resources of the United States, 1992* (Powell et al. 1993). This corrects a 1 million acre omission of reserved forest lands in Washington State that was discovered after the publication of Powell et al., and will be corrected in future RPA publications, according to Forest Service staff.

Table A-1a. Forest land area in the United States by ownership, RPA region, and State, 1992, Western States

	Acreage grouped by ownership type							
State	*All Owners*	*Total Public*	*Total Private*	*Forest Service*	*Other Federal**	*Other Public*	*Forest Industry*	*Other Private*
				(Thousand Acres)				
Arizona	19,595	11,674	7,921	8,873	1,854	947	12	7,909
Colorado	21,338	15,289	6,049	10,028	4,606	655	0	6,049
Idaho	21,621	18,231	3,390	16,100	989	1,142	1,284	2,106
Montana	22,512	16,246	6,266	13,833	1,664	749	1,618	4,648
Nevada	8,938	8,408	530	2,395	6,010	3	0	530
New Mexico	15,296	9,253	6,043	7,178	1,184	891	0	6,043
Utah	16,234	13,236	2,998	5,146	7,472	618	0	2,998
Wyoming	9,966	7,989	1,977	4,838	2,873	278	37	1,940
INTERMOUNTAIN	**135,500**	**100,326**	**35,174**	**68,391**	**26,652**	**5,283**	**2,951**	**32,223**
ALASKA	**129131**	**99327**	**29804**	**11250**	**66152**	**21925**	**0**	**29804**
Oregon	27,997	17,153	10,844	12,661	3,399	1,093	5,208	5,636
Washington	21,432	11,624	9,808	7,586	543	3,495	4,304	5,504
PACIFIC NW	**49,429**	**28,777**	**20,652**	**20,247**	**3,942**	**4,588**	**9,512**	**11,140**
California	37,263	20,229	17,034	15,588	3,642	999	3,280	13,754
Hawaii	1,748	593	1,155	0	52	541	0	1,155
PACIFIC SW	**39,011**	**20,822**	**18,189**	**15,588**	**3,694**	**1,540**	**3,280**	**14,909**
TOTAL WEST	**353,071**	**249,252**	**103,819**	**115,476**	**100,440**	**33,336**	**15,743**	**88,076**
TOTAL U.S.	**737,633**	**313,878**	**423,755**	**139,944**	**109,187**	**64,747**	**71,209**	**352,546**

*Includes Bureau of Land Management, Park Service, Department of Defense, and all other federal ownerships. Source: USDA Forest Service, Forest Statistics of the United States, 1992

Table A-1b. Forest land area in the United States by ownership, RPA region, and State, 1992, Eastern States

State	All Owners	Total Public	Total Private	Forest Service	Other Federal*	Other Public	Forest Industry	Other Private
	Acreage grouped by ownership type							
				(Thousand Acres)				
Connecticut	1,819	239	1,580	0	14	225	4	1,576
Delaware	389	16	373	0	2	14	31	342
Maine	17,533	823	16,710	52	47	724	8,123	8,587
Maryland	2,700	394	2,306	0	50	344	131	2,175
Massachusetts	3,203	559	2,644	0	17	542	66	2,578
New Hampshire	4,981	923	4,058	718	18	187	659	3,399
New Jersey	2,007	557	1,450	0	28	529	0	1,450
New York	18,713	3,724	14,989	6	91	3,627	1,052	13,937
Pennsylvania	16,969	4,308	12,661	466	102	3,740	626	12,035
Rhode Island	401	63	338	0	0	63	4	334
Vermont	4,538	570	3,968	321	0	249	410	3,558
West Virginia	12,128	1,359	10,769	1,011	174	174	891	9,878
NORTHEAST	**85,381**	**13,535**	**71,846**	**2,574**	**543**	**10,418**	**11,997**	**59,849**
Illinois	4,266	618	3,648	247	68	303	13	3,635
Indiana	4,439	667	3,772	178	179	310	18	3,754
Iowa	2,050	244	1,806	0	74	170	0	1,806
Michigan	18,253	6,820	11,433	2,459	181	4,180	2,006	9,427
Minnesota	16,718	9,401	7,317	2,625	329	6,447	761	6,556
Missouri	14,007	2,382	11,625	1,443	347	592	222	11,403
Ohio	7,863	778	7,085	188	0	590	175	6,910
Wisconsin	15,513	4,615	10,898	1,392	239	2,984	1,197	9,701
NORTH CENTRAL	**83,109**	**25,525**	**57,584**	**8,532**	**1,417**	**15,576**	**4,392**	**53,192**

Table A-1b (continued). Forest land area in the United States by ownership, RPA region, and State, 1992, Eastern States

State	Acreage grouped by ownership type							
	All Owners	Total Public	Total Private	Forest Service	Other Federal*	Other Public	Forest Industry	Other Private
				(Thousand Acres)				
Kansas	1,359	68	1,291	0	50	18	3	1,288
Nebraska	722	96	626	37	5	54	0	626
North Dakota	462	51	411	0	22	29	0	411
South Dakota	1,690	1,080	610	973	14	93	21	589
GREAT PLAINS	**4,233**	**1,295**	**2,938**	**1,010**	**91**	**194**	**24**	**2,914**
Florida	16,549	3,437	13,112	1,063	1,306	1,068	4,796	8,316
Georgia	24,137	2,151	21,986	855	865	431	4,990	16,996
North Carolina	19,278	2,503	16,775	1,212	771	520	2,252	14,523
South Carolina	12,257	1,251	11,006	598	358	295	2,626	8,380
Virginia	15,858	2,503	13,355	1,585	566	352	1,614	11,741
SOUTHEAST	**88,079**	**11,845**	**76,234**	**5,313**	**3,866**	**2,666**	**16,278**	**59,956**
Alabama	21,974	1,205	20,769	648	250	307	4,795	15,974
Arkansas	17,864	3,354	14,510	2,488	461	405	4,386	10,124
Kentucky	12,714	1,286	11,428	670	409	207	205	11,223
Louisiana	13,864	1,320	12,544	577	234	509	3,937	8,607
Mississippi	17,000	1,873	15,127	1,149	352	372	3,267	11,860
Oklahoma	7,539	613	6,926	244	224	145	1,077	5,849
Tennessee	13,612	1,850	11,762	627	712	511	1,122	10,640
Texas	19,193	925	18,268	636	188	101	3,986	14,282
SOUTH CENTRAL	**123,760**	**12,426**	**111,334**	**7,039**	**2,830**	**2,567**	**22,775**	**88,559**
TOTAL EAST	**384,562**	**64,626**	**319,936**	**24,468**	**8,747**	**31,411**	**55,466**	**264,470**
TOTAL U.S.	**737,633**	**313,878**	**423,755**	**139,944**	**109,187**	**64,747**	**71,209**	**352,546**

* Includes Bureau of Land Management, Park Service, Department of Defense and all other federal ownerships. Source: Powell et al. 1993.

Table A-2a. Forest and timberland area in the United States by ownership, population, RPA region, and State, 1992, Western States

State	Forest Land: All Owners	Forest Land: Total Public	Forest Land: Total Private	Timberland: All Owners	Timberland: Total Public	Timberland: Total Private	Population and Forests: Total population (1,000's)	Acres/100 people: Forest	Acres/100 people: Timber	Recreation and Timber, Acres/100 people: Pub Forest	Recreation and Timber, Acres/100 people: Priv. Timber
	(thousand acres)			(thousand acres)							
Arizona	19,595	11,674	7,921	3,968	2,706	1,262	4,072	481	97	287	31
Colorado	21,338	15,289	6,049	11,740	8,464	3,276	3,710	575	316	412	88
Idaho	21,621	18,231	3,390	14,474	11,230	3,245	1,156	1,870	1,252	1,577	281
Montana	22,512	16,246	6,266	15,863	9,905	5,957	862	2,612	1,840	1,885	691
Nevada	8,938	8,408	530	224	111	112	1,477	605	15	569	8
New Mexico	15,296	9,253	6,043	5,420	3,462	1,958	1,676	913	323	552	117
Utah	16,234	13,236	2,998	3,078	2,481	597	1,944	835	158	681	31
Wyoming	9,966	7,989	1,977	4,332	2,888	1,444	487	2,046	890	1,640	297
INTERMOUNTAIN	**135,500**	**100,326**	**35,174**	**59,099**	**41,247**	**17,851**	**15,384**	**881**	**384**	**652**	**116**
ALASKA	**129,131**	**99,327**	**29,804**	**15,068**	**8,883**	**6,185**	**634**	**20,368**	**2,377**	**15,667**	**976**
Oregon	27,997	17,153	10,844	21,614	13,004	8,609	3,141	891	688	546	274
Washington	21,432	11,624	9,808	16,238	7,286	8,952	5,497	390	295	211	163
PACIFIC NW	**49,429**	**28,777**	**20,652**	**37,852**	**20,290**	**17,561**	**8,638**	**572**	**438**	**333**	**203**
California	37,263	20,229	17,034	16,200	8,786	7,414	32,398	115	50	62	23
Hawaii	1,748	593	1,155	700	338	362	1,221	143	57	49	30
PACIFIC SW	**39,011**	**20,822**	**18,189**	**16,900**	**9,124**	**7,776**	**33,619**	**116**	**50**	**62**	**23**
TOTAL WEST	**353,071**	**249,252**	**103,819**	**128,919**	**79,544**	**49,373**	**58,275**	**606**	**221**	**428**	**85**
TOTAL U.S.	**737,633**	**313,878**	**423,755**	**489,555**	**131,495**	**358,061**	**262,896**	**281**	**186**	**119**	**136**

Table A-2b. Forest and timber land area. and population in the United States by ownership, RPA region, and State, 1992, Eastern States

	Forest Land			Timberland			Population and Forests			Recreation and Timber	
								Acres/100 people		Acres/100 people	
State	All Owners	Total Public	Total Private	All Owners	Total Public	Total Private	Total population (1,000's)	Forest	Timber	Pub Forest	Priv. Timber
		(thousand acres)			(thousand acres)						
Connecticut	1,819	239	1,580	1,768	216	1,553	3,274	56	54	7	47
Deleware	389	16	373	376	13	363	718	54	52	2	51
Maine	17,533	823	16,710	16,987	527	16,460	1,236	1,419	1,374	67	1,332
Maryland	2,700	394	2,306	2,424	246	2,178	5,078	53	48	8	43
Massachusetts	3,203	559	2,644	2,960	430	2,529	5,976	54	50	9	42
New Hampshire	4,981	923	4,058	4,760	713	4,047	1,132	440	420	82	358
New Jersey	2,007	557	1,450	1,864	464	1,400	7,931	25	24	7	18
New York	18,713	3,724	14,989	15,744	993	14,752	18,178	103	87	20	81
Pennsylvania	16,969	4,308	12,661	15,850	3,390	12,459	12,134	140	131	36	103
Rhode Island	401	63	338	371	45	326	1,001	40	37	6	33
Vermont	4,538	570	3,968	4,429	470	3,959	597	760	742	95	663
West Virginia	12,128	1,359	10,769	11,916	1,170	10,746	1,824	665	653	75	589
NORTHEAST	**85,381**	**13,535**	**71,846**	**79,449**	**8,677**	**70,772**	**59,079**	**145**	**134**	**23**	**120**
Illinois	4,266	618	3,648	4,030	389	3,641	11,853	36	34	5	31
Indiana	4,439	667	3,772	4,296	535	3,761	5,820	76	74	11	65
Iowa	2,050	244	1,806	1,944	156	1,788	2,861	72	68	9	62
Michigan	18,253	6,820	11,433	17,442	6,196	11,245	9,575	191	182	71	117
Minnesota	16,718	9,401	7,317	14,773	7,602	7,171	4,619	362	320	204	155
Missouri	14,007	2,382	11,625	13,377	2,019	11,359	5,286	265	253	45	215
Ohio	7,863	778	7,085	7,567	519	7,049	11,203	70	68	7	63
Wisconsin	15,513	4,615	10,898	14,921	4,215	10,706	5,159	301	289	89	208
NORTH CENTRAL	**83,109**	**25,525**	**57,584**	**78,350**	**21,631**	**56,720**	**56,376**	**147**	**139**	**45**	**101**

Table A-2b (continued). Forest and timber land area. and population in the United States by ownership, RPA region, and State, 1992, Eastern States

State	Forest Land			Timberland			Population and Forests			Recreation and Timber	
							Total population (1,000's)	Acres/100 people		Acres/100 people	
	All Owners	Total Public	Total Private	All Owners	Total Public	Total Private		Forest	Timber	Pub Forest	Priv. Timber
		(thousand acres)			(thousand acres)						
Kansas	1,359	68	1,291	1,208	46	1,162	2,601	52	46	3	45
Nebraska	722	96	626	536	55	481	1,644	44	33	6	29
North Dakota	462	51	411	338	35	304	637	73	53	8	48
South Dakota	1,690	1,080	610	1,447	1,005	442	735	230	197	147	60
GREAT PLAINS	**4,233**	**1,295**	**2,938**	**3,529**	**1,141**	**2,389**	**5,617**	**75**	**63**	**23**	**43**
Florida	16,549	3,437	13,112	14,983	2,434	12,549	14,210	116	105	24	88
Georgia	24,137	2,151	21,986	23,631	1,645	21,986	7,102	340	333	30	310
North Carolina	19,278	2,503	16,775	18,710	1,950	16,760	7,150	270	262	35	234
South Carolina	12,257	1,251	11,006	12,179	1,173	11,006	3,732	328	326	34	295
Virginia	15,858	2,503	13,355	15,292	1,953	13,338	6,646	239	230	38	201
SOUTHEAST	**88,079**	**11,845**	**76,234**	**84,795**	**9,155**	**75,639**	**38,840**	**227**	**218**	**30**	**195**
Alabama	21,974	1,205	20,769	21,941	1,172	20,770	4,274	514	513	28	486
Arkansas	17,864	3,354	14,510	17,423	3,132	14,291	2,468	724	706	136	579
Kentucky	12,714	1,286	11,428	12,360	960	11,400	3,851	330	321	33	296
Louisiana	13,864	1,320	12,544	13,855	1,311	12,544	4,359	318	318	30	288
Mississippi	17,000	1,873	15,127	16,991	1,865	15,126	2,666	638	637	70	567
Oklahoma	7,539	613	6,926	6,122	590	5,532	3,271	230	187	19	169
Tennessee	13,612	1,850	11,762	13,275	1,518	11,756	5,228	260	254	35	225
Texas	19,193	925	18,268	12,546	799	11,749	18,592	103	67	5	63
SOUTH CENTRAL	**123,760**	**12,426**	**111,334**	**114,513**	**11,347**	**103,168**	**44,709**	**277**	**256**	**28**	**231**
TOTAL EAST	**384,562**	**64,626**	**319,936**	**360,636**	**51,951**	**308,688**	**204,621**	**188**	**176**	**32**	**151**
TOTAL U.S.	**737,633**	**313,878**	**423,755**	**489,555**	**131,495**	**358,061**	**262,896**	**281**	**186**	**119**	**136**

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The artwork illustrating forest successional stages on pages 7–9 are reproduced courtesy of Boise Cascade Corporation. They were developed using landscape and forest stand visualization software (LMS) created in the University of Washington's College of Forest Resources. Copies of the software and examples of its product are available on the World Wide Web at *<silvae.cfr.washington.edu>*.

The drawing depicting changes in stand structure (p. 9) was created by Dianna Sampson from the original chart created by Dr. Chad Oliver of the University of Washington's College of Forest Resources. See Oliver et al. 1997.

The nitrogen deposition map on page16 was downloaded from *<http://nadp.nrel.colostate.edu/NADP/>*. A variety of maps illustrating atmospheric deposition are regularly updated on this site. Citation: National Atmospheric Deposition Program (NRSP-3)/National Trends Network. (1997). NADP/NTN Coordination Office, Illinois State Water Supply, Champaign, IL 61820.

The forest biomass map on page 34 was provided by Sandra Brown, Dept. of Natural Resources and Environmental Sciences,University of Illinois (on leave to with the Environmental Protection Agency, Corvallis, OR). It is part of an unpublished study of biomass dynamics in the forests of the Eastern United States, based on USDA Forest Service survey plots. Citation: Brown, S., P. Schroeder, and J. Kern. 1997. Forest biomass map of the eastern USA. Manuscript in preparation.

The general forest type maps on pages 21, 36, and 47–57 were developed from CD-ROM data on "Forest Maps of the United States, 1993 RPA Program: Forest Type Groups and Forest Density from Satellite Data," Starkville, MS: Southern Forest Experiment Station, USDA Forest Service, December 1992. State and regional boundaries were taken from the geographic data distributed with CITYgreen, an AMERICAN FORESTS' geographic analysis program that runs on ArcView 3.0.

The general forest type map of Alaska on p. 45 was reproduced from the map "Forest Type Groups of the United States," distributed as a supplement in Powell et al. (1993).

The GIS maps on pp. 61–62 were prepared by Ava Strand in the Landscape Dynamics Laboratory, University of Idaho College of Forestry, Wildlife, and Range Sciences.

Appendix D. About the Forest Policy Center

The Forest Policy Center, a department of AMERICAN FORESTS, serves as a bridge between the scientific community and policymakers, providing timely, impartial synthesis of scientific information relating to current issues in the protection and sustainable management of forest ecosystems while recognizing environmental, social, and economic considerations. Since the establishment of the Forest Policy Center in 1991, the Center continues to make important contributions to the protection and sustainable management of forest ecosystems in the United States and abroad.

What We Do

- Promote dialogue among diverse interests by organizing meetings, workshops, symposiums, roundtables, collaborative projects, and conducting field tours.
- Produce timely and concise information through reports and discussion papers written for scientists, policymakers, and general audiences.
- Reach out and work in partnership with local organizations and community-based groups in order to create stronger linkages with regional and national organizations and bring key policy concerns to the national arena

Current Initiatives

- Defining sustainable forest management at the community level.
- Promoting constructive dialogue among relevant interest groups by providing credible, objective information and building communication networks.
- Identifying practical approaches to implementing ecosystem management on mixed ownership landscapes.
- Building support for community-based approaches to ecosystem management.
- Assessing carbon and economic implications of ecosystem-based forest management practices.

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